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The Great Gnomon at Florence.

By W. ALFRED PARR.

OF the crowds of worshippers who, on Midsummer Day, yearly assemble beneath the vast dome of the Cathedral at Florence to commemorate the festival of San Giovanni, the patron-saint of their city, but

Fig. 1.—The Cathedral (Sta. Maria del Fiore) at Florence, from the south; showing the window in the lantern to which the Gnomon is attached.

few probably give a thought to the astronomical significance of the day they are celebrating. Yet Brunelleschi's wonderful dome—over 138 feet in diameter, and, with its lantern, 387 feet high*—which marked an epoch in architecture, and was the first great triumph of the Renaissance, forms, with its famous gnomon, placed there by the Florentine cosmographer Paolo Toscanelli about the middle of the 15th century, undoubtedly the most stupendous astronomical instrument for determining the summer solstice that the world possesses. So, at least, thought the great Lalande in 1765, when he wrote: "La méridienne que l'on voit dans la Cathédrale de Florence est le plus grand monument d'Astronomie qu'il y ait au monde.' But that was some 30 years before his countrymen gave to the world, as an earnest of the eventful expedition culminating in the Battle of the Pyramids, that memorable work, the "Description de l'Égypte," which has formed the starting-point for our present day knowledge of the design and orientation of many of the great temples on the banks of the Nile. Compared with some of these, the Florence "Duomo," considered as a solstitial instrument, must take a very subordinate position in regard to the length of the beam of light utilised.

The temple of Amen-Ra, at Karnak, for instance, was, according to Sir Norman Lockyer, oriented to the summer solstice in such a way that the setting sun flashed a beam of light along its huge axis, something like 500 yards in length, into the sanctuary at the extreme end, heralding to the priests the commencement of a new solar year, and affording them, at the same time, an obvious means of impressing the multitude with a "Manifestation of Ra." At Florence, it is true, Toscanelli's solar apparatus plays no part in the structural scheme of the grand cathedral in which it is placed, although the idea of utilising the ample proportions of a vast public edifice in the interests of astronomy is the same. At Florence, moreover, "the sun had from the South to bring solstitial summer's heat," and thus mark his greatest northern *declination* from the equator instead of being required, as in the sun-god's temple, to register his greatest northern *amplitude* along the western horizon. The method here adopted is, indeed, the venerable one of the *gnomon;* and, having regard to the fact that the Florentine contrivance is higher than the similar apparatus in the churches of S. Petronio, at Bologna (which, by the way, was constructed in 1653 by the first Cassini, the discoverer of the chief division in Saturn's Ring), S. Maria degli Angeli, at Rome, and St. Sulpice, at Paris, put together, Lalande's claim for it may not be so far from the truth as regards this particular form of solstitial instrument.

Situated at a height of nearly 300 feet above the floor of the Cathedral, and firmly built into the marble sill of the southern window in the lantern surmounting the dome, Paolo Toscanelli's famous gnomon must certainly have constituted, together with its solstitial marble let into the pavement far beneath, a very efficient instrument of precision in the days that preceded

* The corresponding dimensions of the dome of St. Paul's are 112 feet and 364 feet respectively.

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the introduction of the transit-circle.* This is evidenced by the fact that its illustrious author, who probably constructed it in 1468, shortly after the completion of the Cathedral, obtained by its means a very accurate value for the obliquity of the ecliptic as then existing; his result of 23° 30′ being a more exact figure than the 23° 28′ found by Purbach and his brilliant pupil Regiomontanus. Whether, however, the gnomon was erected by Toscanelli with a view to determining the *variation* in obliquity, as maintained by Leonardo Ximenes and others, is a question to which Celoria† considers no positive answer can now safely be given. The supposition in itself would involve nothing unreasonable, for this gradual variation in the obliquity of the ecliptic, which the modern examination of ancient monuments,

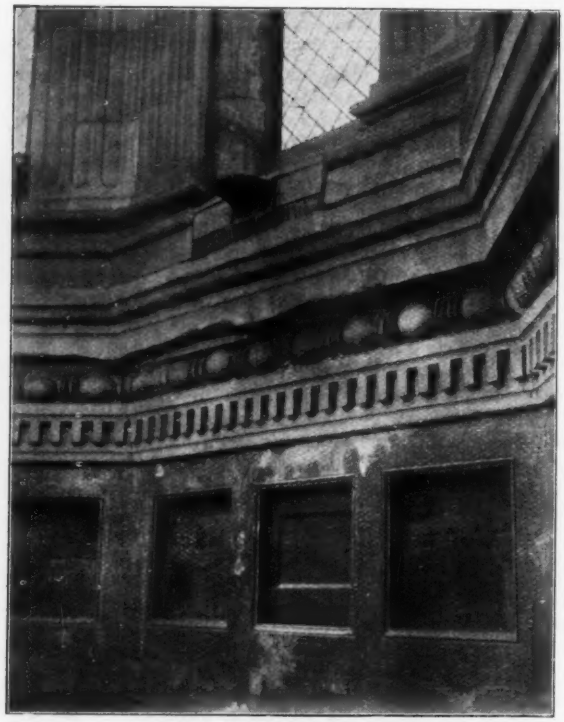


Fig. 2.—The Gnomon at the base of the south window in the lantern. The orifice, being protected by a brass cover, does not show in the photograph.

as well as other researches, lead us to conclude was suspected even among some of the ancients, was certainly known in Toscanelli's day, and it is, therefore, improbable that this remarkable man, who was the author of the map used by Columbus on the voyage which resulted in the discovery of America, should not have borne this matter in mind when constructing his great gnomon.

Nevertheless, the mean annual diminution in obliquity being something like 0″.468, the chief factor—time—in so delicate an investigation as this would necessarily be, carried out with the means then obtainable, would be all but absent. Here, again, the Egyptian sun-god might assert his superior claim to be heard in matters astronomical, for the great temple of Amen-Ra having stood for over 50 centuries, its solstitial orientation now shows a deviation of something like one degree; whereas with the Florence Duomo, which can only boast an existence of a little over four centuries, the observed variation, being comparatively small, would be a matter of considerable difficulty to accurately determine, even supposing the gnomon never to have been displaced from its position, which, as we shall presently see, is unfortunately not the case.

The task which Toscanelli had primarily set himself, however, was undoubtedly the correction of the Alphonsine Tables, which were then in operation, but which gave a very inadequate representation of the true solar motion, more especially as regards the exact length of the tropical year. To correct this error, he knew that it would be necessary to institute regular observations of the sun's motion, and it is for this reason, in all probability, that he undertook the construction of the gnomon. This elaborate care to determine the exact moment of the summer solstice in the Florence Cathedral is not without its significance in view of the annual illumination of the dome on Midsummer Night, or the feast of St. John the Baptist; and the *St. John's fires*, kindled in former times in celebration of the summer solstice, now find their analogue in the display of fireworks, which, to the modern Florentine, forms the chief attraction to the festivities annually observed in honour of his patron-saint, San Giovanni.

As it is, many valuable facts relating to the history of the gnomon have unfortunately been lost, for the original inscription on the marble disc marking the solstitial point, which Toscanelli caused to be let into the pavement of the north transept of the Cathedral, was all but obliterated even in the time of Leonardo Ximenes, whose curious description,* published at Florence in 1757, still forms the classic work on this subject. Surrounding Toscanelli's solstitial disc, and placed eccentrically to it, is a larger circle of a different kind of marble, on which is inscribed the date MDX PRIDIE ID IVNII (12th June, 1510), the day on which the summer solstice fell in that year, owing to the displacement of nine days produced by the Julian Calendar which was then in force, the Gregorian Reform not being introduced until over 70 years later.† This larger circle is thought to be the work either of a nephew of Toscanelli, or, more probably, of a certain Antonio Dulciati (who is said to have written on the reform of the Calendar), and is intended to mark the position of the round patch of light which the sun's rays, passing through the circular orifice of the gnomon in the lantern, formed on the floor of the Cathedral at the time of the summer solstice.

As a matter of fact, both the large and the small circle lie somewhat to the west of the true meridian, thus anticipating the exact time of mid-day by about a minute and a half, and it was partly this error which induced Leonardo Ximenes to draw the meridian line which extends for over 30 feet along the pavement. Ximenes, indeed, who was the founder of the Ximenian Observatory in Florence—the institution which still retains the curatorship of the gnomon—not only made important researches in its history, but himself instituted a series of very careful experiments with this huge sundial. Besides tracing a true meridian, and causing

* Introduced about 1690 by the Danish astronomer, Olaus Römer, who first measured the velocity of light.

† *Sulle osservazioni, etc., fatte da Paolo Dal Pozzo Toscanelli*; Rome, 1894.

* *Del vecchio e nuovo Gnomone fiorentino.* (It is interesting to note that Florio in his quaint Italian-English Dictionary, *A Worlde of Wordes*, defines the Italian *gnomone* as "the *know-man* or *gnowman* of a diall, the shadow whereof pointeth out the howers.")

† Viz., in 1582. The Reform was not adopted in England until 1752.

both this and the solstitial marbles of his predecessors to be covered with a protecting brass,* he at first re-adjusted and then replaced Toscanelli's gnomon by a new one of the same dimensions in every respect; his

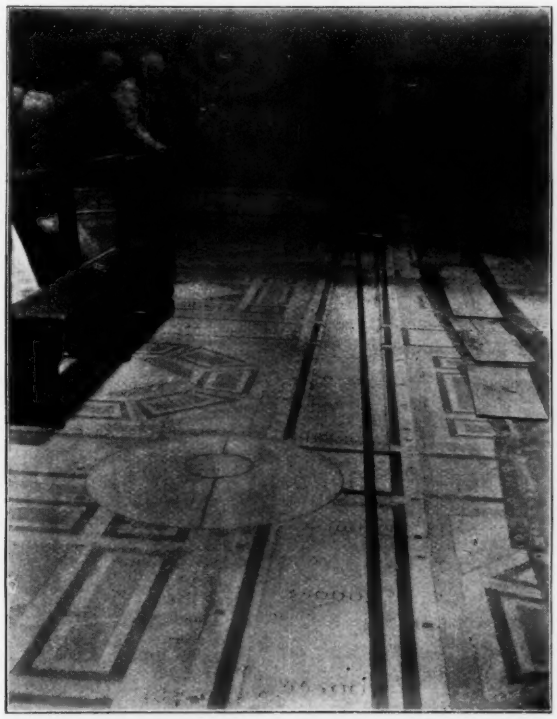


Fig. 3.—The meridian-line and solstitial discs on the pavement of the north transept.

avowed object in bestowing so much care and thought on the apparatus being to bequeath to posterity a means of detecting the slow changes in the obliquity of the ecliptic—the *exiguae eclipticae variationes*, as he very aptly terms them in the long Latin inscription which is affixed to one of the four massive piers sustaining the dome.

But Ximenes' grand design of handing on to future generations an amended edition of this stupendous instrument of research was soon to be frustrated, for even *his* careful corrections were not suffered to remain undisturbed. During some repairs to the lantern his gnomon was removed, and deposited for several years in an adjoining museum; and, although subsequently restored to its position, it was not brought into proper adjustment until 1893, when Padre Giovannozzi,† the present Director of the Ximenian Observatory, again went over the entire work with the greatest precision. Certainly a gnomon subject to fewer vicissitudes might have been obtained had it been possible to carry out the project, once entertained but dismissed as dangerous, of perforating the great dome itself.

Graver difficulties, however, than those occasioned by the hand of the restorer conspire to render this great solstitial instrument now of small value other than an historic one. The fact that only for a little over two months at the time of the summer solstice, can the gnomon be used at all, on account of the normally lower altitude of the sun causing its rays to strike the arches of the dome, would not necessarily impair its scientific value; but the beam of light itself, transmitted through the $1\frac{1}{2}$-inch aperture of the bronze gnomon, is far too seriously affected by atmospheric perturbations, caused by the varying temperature along its extended path from lantern to pavement, to throw more than a very unsteady image on to the meridian below, while that image also, being over four feet in diameter, is of little practical utility from an astronomical point of view; moreover, the expansion due to the sun's heat on the vast building itself would render minute accuracy out of the question.

On the few occasions on which the solstitial observation has been made in recent years, the object has been mainly to detect any slight movement which might have taken place in the fabric of the great Cathedral; and when after the severe earthquake shock of 1895 it was found that the trifling errors in position noted may well have been due to the errors in observation inseparable from this mode of investigation, anxiety for the safety of Brunelleschi's wonderful dome gave place to admiration for the work of its architect. To enhance the effect, it is usual, when carrying out the experiment, to provide the lantern with a temporary flooring, allowing only the beam of light from the

Fig. 4.—Section of the dome, showing the path of the sun's rays at the summer solstice. (After Ximenes.)

orifice in the gnomon to pass down on to the pavement below, while the transept containing the meridian is also darkened, in order to show the disc of sunlight with greater precision.

* This had not been raised for some years, but at my request Signor Pratellesi, the secretary of the Cathedral Office of Works, most kindly had it removed on the occasion of the summer solstice on June 21st last.

† To whom, as well as to the Vice-director, Padre Alfani, I am indebted for much historical information.

Grandly impressive as is the spectacle of the long beam of sunlight falling athwart the darkened Cathedral, it is, nevertheless, only too true that the "pageantry of Nature" has n oplace in the science of to-day, and such investigations as the designers of the gnomon had in mind are now conducted with greater accuracy, if with less magnificence, at the transit-circle of every properly equipped observatory. We now know that the gradual change in the tilt of our planet's axis to the plane of its path round the sun, or the ecliptic, which the Florence gnomon was to register for successive ages, occupies a cycle extending through many thousand years, and it has been calculated that this tilt was at a maximum about 7200 B.C., or 9105 years ago, when the inclination of the equator to the ecliptic, or "obliquity of the ecliptic," amounted to 24° 13′. The obliquity is at the present time* 23° 27′ and will reach its minimum of about 22° 30′ some 9600 years hence; a short enough period reckoned from the standpoint of astronomy, but sufficiently long to outlast man's grandest monuments—his most "gorgeous palaces and solemn temples," be the latter dedicated to Amen-Ra, as at Thebes, or to St. Maria del Fiore, as at Florence.

A Sliding Pinnacle.

THE photographs show two views of a slice of a hill which is gradually leaving the mainland and toppling over at the same time. It is to be found near the village of Hebden (near Grassington), in Yorkshire, and, according to the Postmaster there, it must be moving somewhat rapidly towards the valley, for not many years ago it was a favourite walk of the villagers on Sunday evenings to climb the hill and jump across the narrow chasm which at that time separated it from the mainland. Such a feat is, of course, impossible at the present time.

No. 1 shows the appearance of the mass of falling rock as one approaches from Hebden. The rocky remains of some former catastrophe rather prevent one from obtaining a complete idea of the size and inclination of the slice, though the jointed and unequally-weathered nature of the strata is well seen.

No. 1.

No. 2.

No. 2 shows the appearance from the top of the moor looking down towards Hebden, and gives a better idea of the immense size and dangerously overhanging state of the slice.

The surface rock is a hard gritstone, and the slipping may be attributed to unequal weathering of the sandstone layers.

* The exact value for June last was 23° 27′ 5″.70.

DR. H. A. D. JOWETT, who for nearly ten years has filled the position of Senior Research Chemist on the staff of Dr. F. B. Power, Director of the Wellcome Chemical Research Laboratories, is about to leave that position in consequence of his appointment as chief of the Experimental Department at the works of Messrs. Burroughs, Wellcome & Co., Dartford, Kent.

MESSRS. PASTORELLI & RAPKIN, Ltd., have sent us a copy of their illustrated list of Meteorological Instruments, which they have just issued. It comprises all forms of apparatus for observation in this science, both of the standard as well as the self-recording and registered patterns, and should be in the hands of both professional and amateur observers.

The Red Spot and South Tropical Spot on Jupiter.

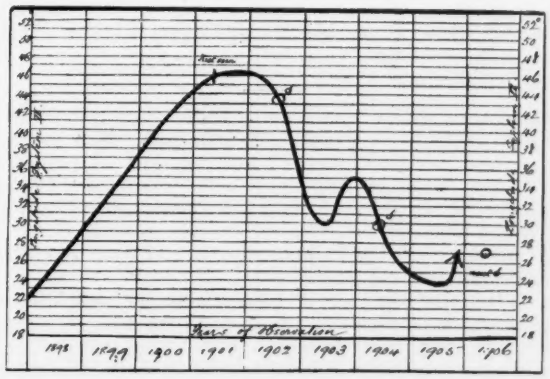
THE red spot has exhibited a very fluctuating rate of motion during the past five years. In 1877 the rotation period of this marking was 9h. 55m. 33·4s., and it showed an uninterrupted, though slightly variable, slackening of speed until 1900, when its period conformed with that adopted for System II. of Marth-Crommelin's Ephemeris, viz., 9h. 55m. 40·63s. Since 1900, however, the rate has oscillated between 9h. 55m. 38s. and 9h. 55m. 42s. In the present year, as in 1900, the object has been running nearly level with the rate of System II., and its longitude has not differed materially from 26° since August, 1904. The following are some observations selected from a large number of transits obtained at Bristol in recent years.

Year.	Date.	Transit Time.	Longitude of Spot.	Telescope and Power.
		H. M.	°	
1898	June 7	9 20	25 9	10 in. Reflector, 312
1899	Feb. 2	18 39	29·5	,, ,, ,,
,,	Sept. 14	3 59	34·7	,, ,, ,,
,,	Dec. 30	17 54	35·7	,, ,, ,,
1900	Feb. 20	20 59	37·4	,, ,, ,,
,,	Sept. 3	7 10	44·4	4 in. Refractor, 240
1901	Feb. 13	17 37	43·5	,, ,, ,,
,,	May 28	13 35	45·9	10 in. Reflector, 312
,,	Sept. 29	5 54	43·6	,, ,, ,,
1902	May 20	14 23	44 7	,, ,, ,,
,,	Dec. 31	5 13½	36·3	,, ,, ,,
1903	May 26	16 18	29·5	,, ,, ,,
1904	Feb. 2	4 52½	36·0	,, ,, ,,
,,	Oct. 29	8 9	26·4	4 in. Refractor, 150
1905	Feb. 2	7 36	25·4	,, ,, ,,
,,	Mar. 27	6 43	24 6	,, ,, ,,
,,	June 24	15 43	25·1	10 in. Reflector, 215
,,	July 16	13 57	24·0	,, ,, ,,
,,	,, 30	15 32	23·8	12½ in. ,, 315
,,	Aug. 1	17 9	22·8	,, ,, ,,
,,	,, 18	16 14	23·1	,, ,, ,,
,,	Sept. 13	17 41	22·7	,, ,, ,,
,,	Oct. 6	11 43	23·8	,, ,, ,,
,,	,, 15	14 11	26·5	,, ,, ,,
,,	,, 17	15 47	25·3	,, ,, ,,
,,	,, 22	14 55	25·8	,, ,, ,,
,,	,, 24	16 37	28·2	,, ,, ,,
,,	Nov. 3	14 52	28·8	,, ,, ,,
,,	,, 6	12 20	28·1	,, ,, ,,
,,	,, 7	8 9	26 8	,, ,, ,,

During the period under review the variable motion of this marking has originated differences in longitude amounting to about 23°. Marked accelerations occurred in 1902 and 1904, while the motion was retarded in the last half of 1903, and during the present autumn another decided slackening appears to be in evidence.

To what cause these irregularities have been due appears somewhat doubtful, but it has been conjectured that a large dusky marking, first seen in the spring of 1901, in about the same latitude (south tropical zone), and moving at a more rapid rate than the red spot, has been the means of quickening the speed of the latter. This south tropical disturbance has a rotation period of nearly 9h. 55m. 19s., and, as it overtakes and passes the red spot, may well exercise some accelerating influence upon it. There is indeed strong evidence to support this conclusion, but more observations are required. The two markings were in conjunction in 1902 (July) and 1904 (June), and the phenomenon will be repeated in 1906 (May) if the rate of motion of the red spot remains approximately the same as during the past twelve months. Taking the mean rotation period of the latter marking in recent years as 9h. 55m. 40s., and that of the south tropical spot as 9h. 55m. 19s., there is a difference of 21 seconds in their times, and this indicates that conjunctions must occur at intervals of about 700 days.

Between the present time and next April (Jupiter will be very near the sun in May and June, 1906) it will be important to secure a large number of accurately observed transits of the red spot for the purpose of determining whether there is any decided increase in its velocity. The south tropical spot is now some 110° east of it (about 3 hours following) and the distance is rapidly closing up. If, therefore, this south tropical disturbance is responsible for the longitudinal displacements of the red spot, the



Variations in motion of the Red Spot during last eight years.

The diagram exhibits the variable motion in longitude of the red spot in and since the year 1898. The conjunctions of this marking with the south tropical spot are also indicated. An inspection of the diagram will show that the motion of the red spot appears to have been accelerated at the time the south tropical spot was first seen, and that both before and after the conjunctions of 1902 and 1904 great accelerations occurred.

fact will shortly become apparent in a marked increase of the normal rate of the latter, and we shall find its longitude becoming less.

In recent months the S. tropical spot has presented a remarkable development, and its length has been augmented from 43°·5 to about 60°. My observations of the p. and f. ends of this object during the past four months have been as under:—

Date, 1905.	Longitude, P. end.	Longitude, F. end.	Length.
	°	°	°
August 7 ..	157·9	201·4	43·5
Sept. 13 ..	140 3	189·9	49·6
Oct. 19 ..	113·3	171·9	58·6
,, 31 ..	113·1	170·5	57·4
Nov. 2 ..	108·4	165·8	57·4
,, 7 ..	109·6	167·0	57·4
,, 11 ..	108·5	170 7	62·2

The increase of length between August 7 and October 19 was 15°, which corresponds to a real distension of about 11,000 miles. This enlargement must have occurred

chiefly at the following side of the spot, which has drifted far East relatively to the rotation of 9h. 55m. 19s., representing the normal rate.

While writing I may note that the present autumn has furnished many excellent observing nights. Between October 7 and 14 the weather was very cloudy, but between October 15 and November 11 there were 22 nights clear and 6 overcast. On quite a large proportion of the clear nights planetary definition was found very sharp. This was especially the case on November 6, when I tried powers of 713, 912, 1210, and 1540 on my 12½ in. reflector. The details could be well seen on Jupiter with the latter power; but the difficulty of getting the image into the field, and keeping it there, rendered the use of lower powers much preferable.

W. F. DENNING.

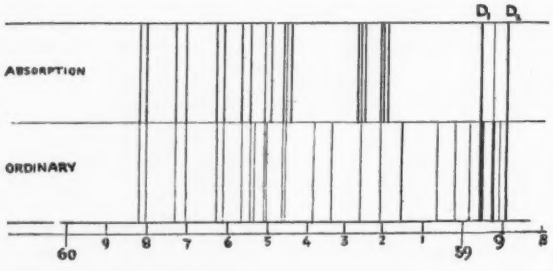
Bristol, *November* 13, 1905.

Note on the Absorption Lines of Water Vapour.

ON comparatively rare occasions the spectrum of sunlight exhibits very pronounced absorption lines due to the atmosphere being very highly charged with water.

These rainbands are particularly prominent in that portion of the spectrum which contains light of wavelengths between .000059 and .000060 centimeters, *i.e.*, in the region extending towards the red from D about one quarter of the way to α

When the positions of these bands are well known they may be detected as faint lines when the air is less heavily laden with moisture, but if the moisture is excessive they form, after the sodium lines, the most prominent features of the spectrum in the region indicated. In London such occasions of excessive



absorption occurred on June 17, 1902, June 6, 7, and 9, and September 6, 1905, and they were taken to fix the position of the prominent bands as indicated in the drawing.

At 59.20 and 59.26 occur two bands, each of them triplets; at 59.45 occurs another triplet, followed by five doublets, the last of which is at 59.82. The atmospheric conditions being favourable the best time for the exhibition of these bands is in the early morning in summer, picking up light from a low point in the East. However, in June of this year there was no difficulty in obtaining them at any hour and at any altitude on the 6th and 7th day of that month.

Unsettled weather always accompanies these strongly-marked bands, and their existence certainly forms a very trustworthy warning of a bad day.

T. H. B.

The Zodiacal Light.

By ARTHUR MEE.

MR. MAUNDER has well shown in his "Astronomy without a Telescope," that an object which requires no instrument to study, which most people can see if they try, and which has been observed for countless generations, still remains to a great extent a mystery. The object is the Zodiacal Light, that nebulous cone which appears in the west after sunset in early spring, and in the east before sunrise in late autumn, and which, bright in the tropics, may still be profitably studied in our less favoured latitudes by anyone whose horizon is not troubled by the glare of artificial light.

Kepler, long ago, came to the conclusion that the Zodiacal Light was an appendage of the sun, and his opinion has on the whole, received the confirmation of modern observers; but much more remains to be done before all the necessary data have been secured, data which in no way depend on the telescope, but must be collected by naked-eye observers, aided by the virtues of accuracy and patience.

It is not our purpose here to deal with the methods of observing and studying the light. These are dealt with fully in the charming work above referred to. But we desire to call attention to some very interesting observations just made by Dr. Simon Newcomb, the eminent American astronomer, which indicate, so far as they go, that the Zodiacal Light lies to the north and south of the sun as well as to the east and west of our great luminary. Prior to Dr. Newcomb's observations no attempt has ever been made with success to observe the Zodiacal Light to the north of the sun; in fact, the feat is one presenting a good deal of difficulty.

To begin with it cannot be done when the sun is less than 18° below the horizon, on account of the interference of twilight, nor must 18° be exceeded to any great extent else there would not be enough of the light left above the horizon to be seen. In fact (as Newcomb points out), unless the minor semi-axis of the light considerably exceeds 18° it may be for ever impossible to distinguish it from twilight itself. The observation may best be made in latitudes such as our own, but there must in addition be a perfectly clear horizon, and the more elevated the post of observation the better. Dr. Newcomb tells us that even in the clear air of the United States he has so far failed, a fact which, in itself, indicates that the observation is a most delicate one, demanding not only a trained eye, but the most perfect of local conditions.

Whilst in Europe this summer the distinguished astronomer determined to try his experiment amongst the mountains of Switzerland. He therefore consulted a Swiss scientist, who advised the Brienzer Rothorn, a summit suitably situated, easily accessible, and nearly 8,000 feet high. Thither Dr. Newcomb repaired on July 26, and made careful observations on that evening and also on the 29th.

At 10 o'clock on the first of the evenings in question the twilight had completely passed, but there was a faint glow over the north-western horizon which, twenty minutes later, was 20° west of north. It afterwards became well marked, and was watched until the haze thickened and put an end to observation.

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At midnight of the 29th the glow was again seen, and Dr. Newcomb made the following note:—

> "12 h. 5 m. to 12 h. 10 m. Local M.T. The characteristic Zodiacal glow distinct and unmistakable—not so bright as ordinarily seen east or west of the sun, yet several grades brighter than the limit of doubt. It extends from a little east of Capella to a region below the pointers. The maximum of brightness is midway between Capella and the north point, say between 10° and 150° east azimuth and at 10° of altitude. The appearance of maximum brightness below Capella was evidently due to the Milky Way."

Dr. Newcomb (who also glimpsed the Gegenschein) believes he has established the fact that in the direction of the sun's axis the Zodiacal Light is brilliant enough to be plainly seen to a distance of about 35° on either side of the sun, and he suggests "that the Zodiacal Light be hereafter described as a luminosity surrounding the sun on all sides, of which the boundary is nowhere less than 35° from the sun, and which is greatly elongated in the direction of the ecliptic."

The Aurora of November 15th.

By W. SHACKLETON.

A FINE display of the Aurora Borealis was witnessed in London on the evening of November 15. I first noticed the phenomena at 9.10 p.m., when the sky about 15° W. of N. appeared illuminated by a crimson glow, with occasional crimson streamers, shooting up towards the zenith. The crimson appearance, however, did not last very long, and by about 9.30 p.m. had entirely disappeared. I was not able to commence spectroscopic observations until the crimson had disappeared, and then I could not trace any red line, but over a considerable area in the sky the green aurora line was very strong, together with two fainter lines more refrangible and apparently a continuous spectrum in the blue violet; the region of spectrum less refrangible than the principal green line appeared a perfect blank. Prof. Fowler informs me that he commenced observation shortly after 9.20 p.m., and was able to trace the green line until 11 p.m.; he also states that on the same morning he observed a brilliant metallic prominence eruption on the W. limb of the sun, and, in addition, there was considerable activity in the large group of spots, in the western hemisphere, as indicated by the reversals and displacements of the bright lines, more especially C. (H_α.)

Royal Geographical Society Meetings.

December 4.—Exploration in the Abai Basin, Abyssinia. By H. Weld Blundell.
December 18.—Exploration in New Guinea (*with Cinematograph Illustrations*). By C. G. Seligman.

Other provisional arrangements are as follows:

Unexplored India. By Colonel Sir T. H. Holdich, K.C.M.G., K.C.I.E., C.B.
The Economic Geography of Australia. By Prof. J. W. Gregory, F.R.S.
Survey and Exploration in Seistan. By Colonel A. H. McMahon, C.S.I., C.I.E.
Exploration in Tierra del Fuego. By Captain Richard Crawshay.
Exploration in the East Tibet Borderlands. By Lieut. Filchner.
Explorations in Bolivia and Peru. By Baron Erland Nordenskjöld.
The Philippine Islands. By Prof. Alleyne Ireland,
Northern Rhodesia. By L. A. Wallace.
The Geographical Influences of Water Plants in Chile. By G. F. Scott Elliot.
Maps of London. By Laurence Gomme.

The Coloration in Mammals and Birds.

By J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S., M.B.O.U., etc.

ALTHOUGH the literature on colour and coloration in the animal kingdom has reached huge dimensions, and the subject is one which has occupied zoologists from the earliest days, yet we are still a long way from a complete understanding of the causes and use of colour. And since any series of facts carefully collected, or a suggestion, however slight, may prove a stepping-stone towards a more complete knowledge of what are undoubtedly the most conspicuous features among animals, I feel that no further excuse is necessary for a paper of whose deficiencies no one is more conscious than the writer.

On the one hand chemists and physiologists have restricted their investigations to the extraction and analysis of pigments, and on the other hand the majority of zoologists have studied coloration from the standpoint of its utility to the organism in its environment. Few, however, have considered the fact that colour has probably its *primary* cause and utility in satisfying some physiological need of the animal, while natural selection has come in secondarily and eliminated the unsuitable, or perfected those colours and markings that were able to be adapted for purposes of protection, warning, &c.

It is not my purpose here to enter into a long discussion, pointing out special cases where natural selection seems to have failed, or where its advocates seem to have overstepped the limits of probability. This has already been done by many writers, and although they may have partially succeeded in showing that natural selection is not sufficient to account for the *cause* of coloration, yet their work has been, in the main, destructive rather than constructive, and it is probably owing to this tendency that the physiological aspect of colour is not more widely accepted to-day.

I do not, therefore, propose in this paper to deal in any way with natural selection, but, rather, to bring to light further evidence in support of the contention that colour is primarily due to the vigour of an animal, so that where we find conditions suitable to a high state of vigour we shall there find a corresponding increase in the colour.

Secondly, I shall try to show that many of the markings and longitudinal stripes on an animal will be found to have their origin in certain spots, which I propose to call "poecilomeres," and I shall attempt to bring forward considerable evidence to show that these "poecilomeres" arise from physiological causes.

Those who have kept and studied live animals know that the state of the coat or plumage is an unfailing criterion of health or sickness, and that without any moult a bird, on recovering from an illness, becomes much brighter and more glossy, and I know of a case in which the black plumage of a bird became quite brown during sickness, and re-gained, to a limited extent, its black and glossy appearance with the return of health.

We may, therefore, take it for granted that when an animal's health becomes in any way affected, the change

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will be visible externally in the animal's coat or plumage.

Before going further it would be well to define exactly what I mean by *vigour*.

I prefer to employ a term which has already been used in a somewhat similar sense by Wallace and other naturalists, rather than coin a new one*

By *vigour* is meant what one would popularly describe as "high fettle" or "condition." An athlete trained for a race is full of "vigour" so far as his muscles are concerned.

Physiologically speaking, however, I mean by "high vigour" that an animal's whole body is in that state of physiological activity which would enable it to stand severe strains and exertions without being adversely affected.

"Activity of nutrition and function" (the phrase is borrowed from Dr. A. E. Durham, in Quain's Medical Dictionary) is the best definition of what I mean by "vigour."

So that:—

The colour of an animal will be primarily dependent on its "activity of nutrition and function" being at a high or low level.

An animal's "vigour" is affected by several causes.

1st. *CLIMATE.* A heading which may be again sub-divided into

(*a*) Temperature.

(*b*.) Food supply.

2nd. *The rise and fall of sexual activity.*

In those animals whose vigour is not constant throughout the year, the changes will take place in correlation with one or other of these causes.

The effects of the first we may call *seasonal change* in contradistinction to the second or *breeding change.*

I now propose to consider the mammals and birds according to the regions (Polar, Tropical, or Temperate), in which they live.

I.—THE POLAR REGIONS.

In the Polar regions the period of extreme cold and scarcity of food is so long as compared with the short, bright summer, and the transition from the one to the other so abrupt that the inhabitants thereof will be subject to violent changes.

The winter follows so quickly after the breeding season that there is no time, as in more temperate regions, for the animal to recuperate after the lowering effects of sexual activity. Such reserve material as is formed will, therefore, be stored up in the form of fat, a condition in which it is most accessible for any subsequent demands that may be made upon it by the body. This storing up of fat, as Captain Barrett-Hamilton has shown†, is one of the concomitants of sluggish metabolism. Here, therefore, we have conditions of low vigour, and in correlation with them we find the animals for the most part white or grey.

In the spring we would expect that the excitability of the breeding season, as well as the higher temperature and more plentiful food, would tend to a high state of vigour, but it must be remembered that the privations of the winter have so lowered the animal's condition, that it is unable to derive full advantage from the more favourable circumstances, and its vigour is, therefore, unable to reach a high level. In correlation with this we find a predominance of duller colours amongst the majority of Polar animals.

How, then, are we to account for the darker animals of these regions, as, for instance, the musk ox, penguins, and raven?

If our suggestion holds good, the fact of these animals being dark coloured in these regions proves that they are able to maintain their full vigour throughout the year, in spite of the cold and scarcity of food.* Now if this be so, we ought to find these animals throughout the world equally highly coloured or more so, or it is conceivable that if their "vigour" is so great in cold localities, it might become too great in warmer regions, and being unable to find any outlet for this excess (the animal being already highly coloured), death might ensue†, and such animals would, in consequence, be restricted to the colder portions of the world. The raven is a good example of the first of these conditions, for the Corvidæ exist practically unchanged throughout the world, and the musk ox and lemming fulfil the second. The mouse hares (*Ochotona*), although Alpine rather than Arctic, give us a good idea of seasonal change, and show us that the amount of "vigour," rather than the climate, may affect their colour.

For example, two species—*O. ladacensis* and *O. roylei*—inhabit adjacent countries where climatic conditions are very similar. *Ladacensis* is white, or nearly so in winter, and light brown in summer, whereas *roylei*, which becomes bright red in summer, never becomes paler than iron grey in winter.

So that here we have two nearly-allied species inhabiting the same country, each equally influenced by the climate so as to cause them to undergo a seasonal change, yet in winter one is white and the other—in defiance of the laws of protection—dark. Captain Barrett-Hamilton has also brought to my notice another similar instance in the case of the Siberian lemmings (*Dichrostonyx* and *Lemnus*), where the light or protectively-coloured species is much scarcer than its more conspicuous relative.

The penguins, again, are birds whose nature is such as to enable their "vigour" to reach its fullest extent in Antarctic regions at all times of the year. It is not surprising, therefore, to find several specimens, *e.g.*, the emperor penguin, indulging in patches of bright colours, such as yellow, orange, or red, thus affording a further proof that "vigour" rather than "climate" is the prime factor in determining the coloration.

To carry our point further, we should expect to find the vigorous, dark Arctic species breeding earlier than those that are paler coloured, and in confirmation of this we find the raven breeding very early in April, while the ptarmigan and grouse wait till the latter end of May.

The lemming is another instance, for it is a brightly-coloured animal, and in certain seasons produces young more numerously and rapidly than any other Arctic animal, while as a result of this excessive "vigour," we find it most pugnacious and energetic.

(To be continued.)

*The following writers may be said to have written on the subject from this standpoint, viz.; Bateson, Barrett-Hamilton, Beddard, Cunningham, Geddes and Thompson, Newbigin, Tylor and Wallace.

† *Proc. Roy. Irish Acad.* Vol. 24, Sect. B., Pt. 4., P. 307 (1903).

* It might be argued against this that in these cases, the colour having been placed in the hair, it could not be withdrawn, and not being harmful, but even, perhaps, useful (as has been suggested for the musk ox), the animal was enabled to survive. If these animals only moulted in spring, such an argument might hold good; but in the case of the raven, the moult is in autumn, and I fancy the same holds good for the penguins.

† The excessive energy of white men on first coming to the tropics is a frequent cause of their overtaxing their powers, so frequently culminating in drink or fever.

Seismoscopes.

By CHARLES DAVISON, Sc.D., F.G.S.

INSTRUMENTS designed for the registration of earthquakes may be divided into three classes : (1) those which give the time of occurrence only; (2) those which record and magnify the actual movement of the ground without any determination of time or duration, and (3) those which register the time, amplitude and period of every vibration, so that the actual movement of the ground may be completely realised. Those belonging to the first class are usually known as *seismoscopes*, and those of the second and third classes as *seismographs*. The latter as a rule are elaborate and costly apparatus, and can only be constructed by skilled workers and with the aid of refined tools. On the other hand, some forms of seismoscopes may be easily and cheaply made, and the errors due to home-manufacture are not of much consequence. They establish, what is an important fact, that a disturbance of some kind has taken place, and, without much trouble, they may be made to record its time of occurrence.

In a paper published in "KNOWLEDGE" for August, 1896, a few suggestions were offered for the observation of earthquakes without instrumental aid. The present paper, which may be regarded as a supplement to the other, contains descriptions of a few of the simplest kinds of time-recording seismoscopes.

Every such seismoscope consists of two distinct parts, one for magnifying the movements of the ground, and the other for recording the time. In the latter part, there is some, though not great, variety, seismoscopes, otherwise different, making use of the same kind of recorder. A good clock, or one the error of which is known, is its essential feature. The simplest type of seismoscope is one in which some arrangement is made for stopping a clock, or starting a clock (previously fixed at some known time), at the instant when an earthquake occurs and attains sufficient strength to affect the instrument. In the best form of all, the record is made without stopping or in any way affecting the motion of the clock, and it is obvious that, in a country where earthquakes are at all frequent, this kind should be adopted whenever possible. Even in Great Britain, many records may be lost if the instrument is put out of action by the first tremor of a series. For instance, within seven hours on the night of December 16-17, 1896, at least ten earthquake-shocks were felt in the neighbourhood of Hereford ; while, during a still shorter interval in the early morning of September 18, 1901, one observer near Inverness counted no fewer than twenty shocks.

Mallet's Seismoscope.

One of the earliest and simplest seismoscopes adapted for stopping clocks was that devised by the well-known seismologist, Robert Mallet. This is shown in fig. 1, in which A represents the bob of the clock pendulum, B a piece of stout wire passing through the centre of the bob at right angles to the plane in which the pendulum oscillates, and C D a strip of wood, an inch or an inch-and-a-half wide and a quarter-of-an-inch thick, weighted at the end C, and turning freely about a pin driven into the wall or some steady support at the end D. This lath passes through holes in the side of the clock-case, and its lower edge is cut into teeth in that portion which covers the arc of oscillation of the pendulum. E is a log of heavy wood, four to five feet in height and five or six inches square ; the lower end, which rests on the ground, is cut off square, and the top is cut down to about a quarter-of-an-inch square, so that the lath C D may rest upon it. When

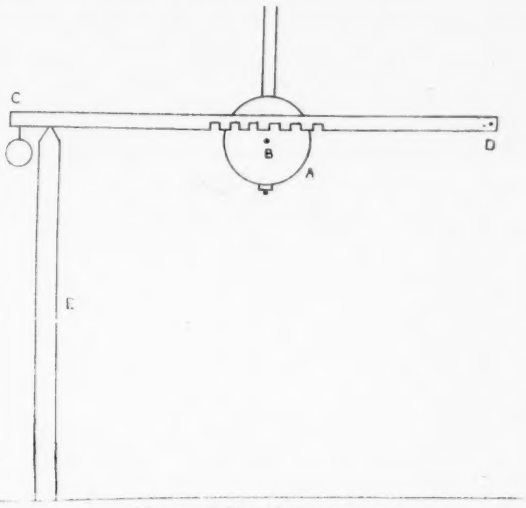

Fig. 1.—Mallet's Seismoscope.

the log E is overthrown by a shock, the lath C D falls, and the teeth, catching the pin B, will stop the clock.* The dimensions of the apparatus may obviously be varied at pleasure ; its chief defect lies in the roughness of the starter E.

Milne's Seismoscope.

Professor Milne's seismoscope is free from this defect, in having a more sensitive arrangement for dropping the lath C D. Instead of the column E (fig. 1.), he uses a simple horizontal pendulum E G C (fig. 2.), which is more readily displaced by a weak shock. The lath C D and the pendulum bob are arranged as by Mallet, but the lath ends at C in a piece of wire. E C is a straight wire, passing through a

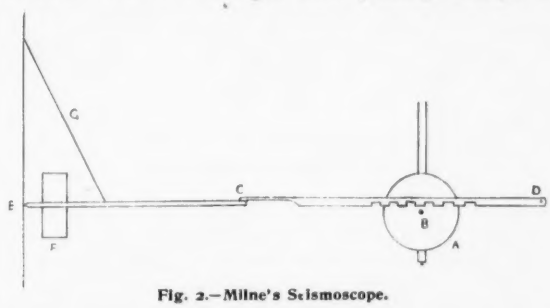

Fig. 2.—Milne's Seismoscope.

disc of lead F. The end E is sharpened and rests in a small conical hole made in the head of a drawing-pin pressed into the side of the clock-case, and the wire E C is supported in a horizontal position by a silk thread G fastened to the clock-case at the upper end by

*In another form of seismoscope suggested by Mallet, two strings pass from the log of wood through the sides of the clock-case, and are fastened to the pin at the lower end of the pendulum. The lengths of the strings are adapted so that, while hanging loose within the clock case, they permit the pendulum to swing freely ; but stop it immediatly the log E is thrown down by a shock.

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a drawing-pin or nail vertically over the pin at E. A very slight movement of the clock-case displaces the wire E C, and the lath C D falls as before and stops the clock.

Marvin's Seismoscope.

Professor Milne's seismoscope may easily be constructed with home-made appliances. The next two instruments, designed by Professor C. F. Marvin and Dr. G. Agamennone, are of less simple form. Professor Marvin's seismoscope, which is in use in the United States, is illustrated in fig. 3. A heavy weight A is suspended from the frame B by means of a steel

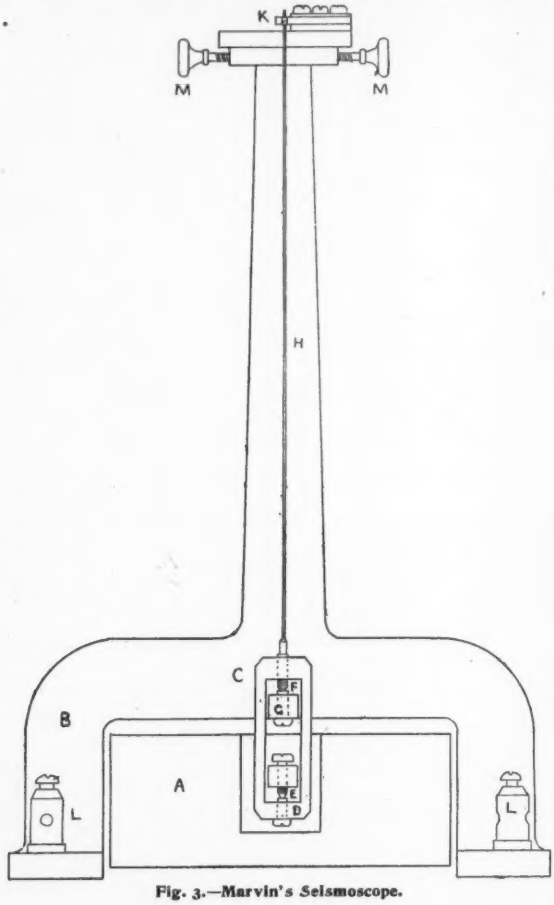

Fig. 3.—Marvin's Seismoscope.

link C, which passes partly through the centre of the weight. At the bottom of the link is a small hole D, into which fits the sharp point of a screw E rigidly connected with the weight, and so adjusted that the point is just above the centre of gravity of the weight. At the top of the link is a similar pointed screw F, resting in a hole made in a projection G from the frame B. When suspended in this manner, the weight A is obviously in stable equilibrium. From the top of the link C there projects upwards a slender and flexible pin H, about six inches long. The upper end of the pin is tipped with platinum and passes through a small hole (also lined with platinum) in the plate K at the top of the instrument. This plate is electrically insulated from the frame B, but is connected by a wire with one of the binding screws L fixed to the base. The position of the plate can be adjusted by means of four screws M (only two of which are shown in the figure) so that, when the seismoscope is in working order, the tip of the pin H is exactly in the centre of the hole in the plate. The binding screws L are connected with the poles of a battery.

When an earthquake occurs, the frame B moves with the ground, but the heavy weight A remains nearly at rest. The movement of the frame with respect to the weight is magnified several times at the upper end of the needle H; and, if the original displacement is great enough, the tip of the needle touches the side of the hole in the plate K, and completes the circuit. By such means, a clock may be stopped, and, if desired, an electric bell may be rung to give notice that the clock requires attention; or a record may be made on a strip of paper moved by clockwork.

The latter method is that which is employed in the United States Weather Bureau, at Washington. The time-recorder there is the so-called "weekly anemometer register." This consists of a horizontal cylinder covered by a sheet of paper and revolving by clockwork once in six hours. A pen rests lightly on the paper as the latter passes underneath. The pen is connected with an electro-magnet fixed to the base of the register, and this again with the seismoscope, and, when the circuit is closed during the occurrence of an earthquake, the pen is slightly displaced to one side, and the record of a shock consists of a notch in an otherwise uniform line. The paper is marked with lines corresponding to intervals of five minutes, but, as the clock which drives the cylinder cannot be depended on for keeping accurate time, the electro-magnet is also connected with a good pendulum clock so adapted that the circuit is closed momentarily once every five minutes. "The record of an earthquake," Professor Marvin remarks, "consists of a succession, more or less prolonged, of lateral jogs or strokes on the line traced by the pen, whereas the clock record consists of a single stroke occurring regularly and of very short duration." The paper is driven at the rate of $2\frac{1}{2}$ inches an hour, and it is thus not difficult to determine the time of a shock to within a quarter or half a minute.

Agamennone's Seismoscope.

At first sight, there is some resemblance between Dr. Agamennone's seismoscope and Professor Marvin's. The principal difference lies in the fact that the perforated plate is itself movable and magnifies the original displacement of the ground. The seismoscope is thus doubly sensitive. It is used chiefly in Italian observatories, but is also to be found in Hungary, Roumania, Bulgaria, India, the Dutch Indies, etc.

The base A of the instrument (fig. 4.) is a circular plate of cast iron, standing on three equidistant feet, two of which are levelling screws. Three vertical rods, B, C, and D, rise upwards from three points of the base which form the angular points of an equilateral triangle. The rod B is made of steel, and is about 14 inches long, the lower part, $2\frac{1}{2}$ inches in length, being a thick steel wire, and the upper portion a fine steel rod, $\frac{1}{25}$th of an inch in diameter, and ending at the tip in a short platinum wire. A lens-shaped disc of lead E, weighing a little less than half-a-pound, is fixed by a screw to the rod B near its lower end. The second rod C is of twice the thickness of the other, and of about the same length, and carries at its upper end a similar disc of lead F, fixed to it by a screw. To this disc is attached a small horizontal plate of platinum G, perforated by a small round hole and so adjusted that

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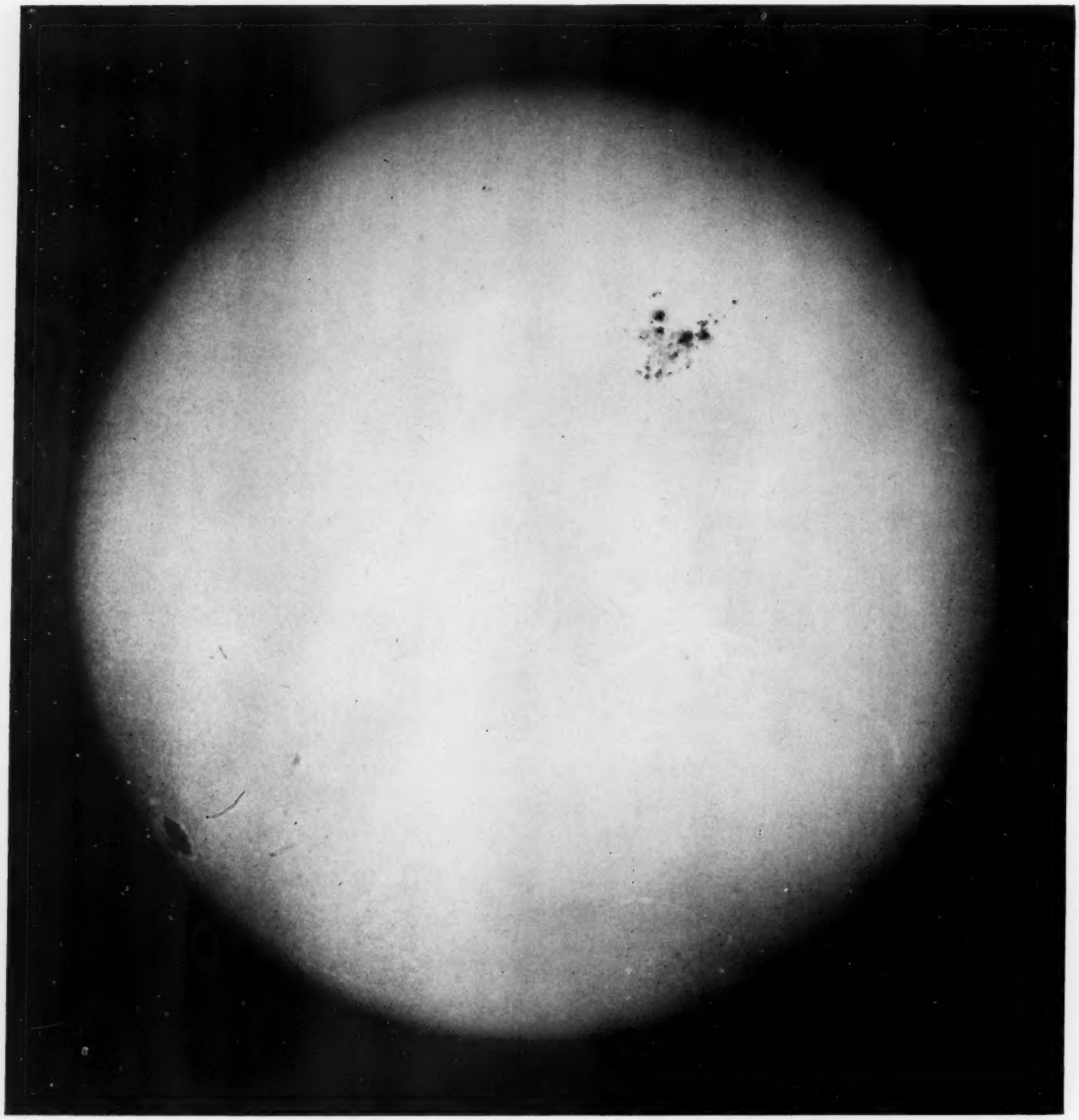

Photograph of the Sun, October 22nd, 1905.

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the platinum tip of the rod B passes exactly through its centre. Thus, as both the rod B and the hole in the plate G are subject to displacement, and as the rods

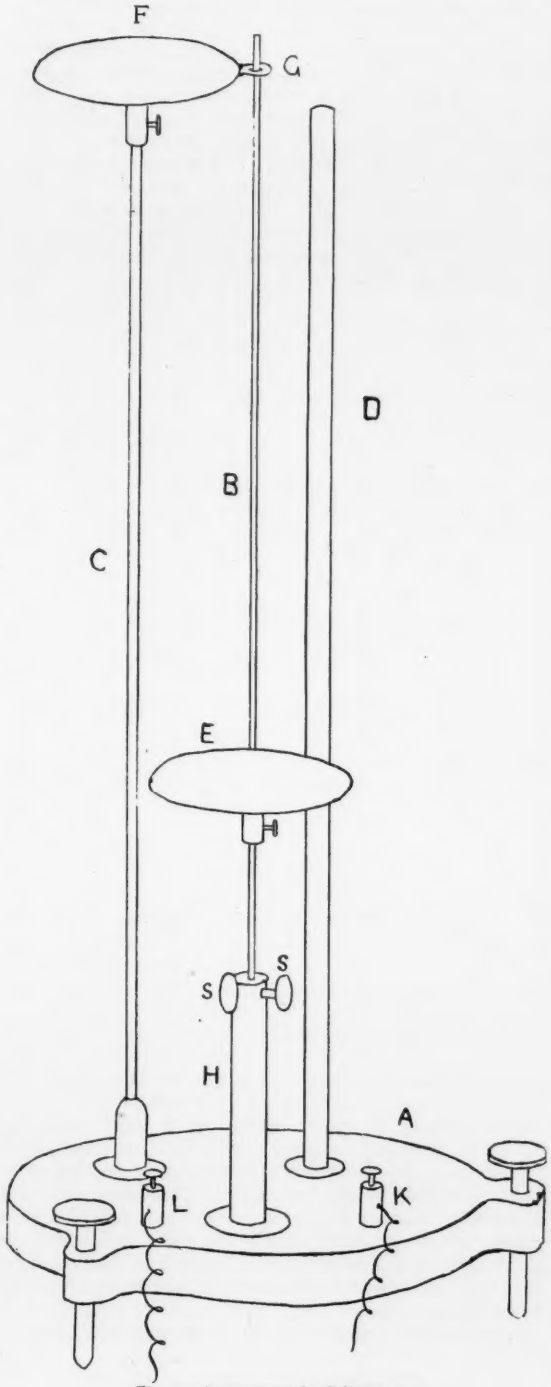

Fig. 4.—Agamennone's Seismoscope.

B and C have different rates of vibration, it is obvious that a very small movement of the ground is sufficient to bring the tip of the rod B into contact with the rim of the hole in the plate G.

This forms the essential part of the apparatus, but several details are required in order to adjust the tip of the rod centrally within the hole. In the earlier forms of the apparatus, the plate G was attached to an arm springing from the rod C, and provided with two screws at right angles to one another for making the necessary adjustment. But, as the rod C vibrates more rapidly than the rod B, it was found advisable to transfer the adjusting apparatus to the latter. The thick steel wire, which forms the lower part of the rod B, is fixed to the bottom of a strong tube of brass H, let into the base A. At the top, this tube ends in a brass ring, in which work two screws S and S, at right angles to one another, which press against the thick steel wire forming the lower portion of the rod B. With this change, the necessary adjustments are made more easily than in the earlier forms of the instrument; but, to attain this end still more rapidly, the stout rod D is provided, by touching which the oscillations are quickly damped.

The two rods B and C are electrically insulated by discs of ebonite from the base of the apparatus, and are connected with the binding screws K and L, and these again with the binding screws of the seismoscope clock. This is an ordinary clock, the pendulum of which is drawn to one side and held back by a small tooth at one end of a lever. Immediately the platinum tip of the rod B touches the rim of the hole in the plate G, the circuit is completed, an electro-magnet fixed to the base of the clock raises the toothed end of the lever, and the pendulum is thus released. If the clock is previously set at some known time, say twelve, the time indicated by the clock when next observed gives the time that has elapsed since the beginning of the shock. If an electric bell is included in the circuit, attention may be drawn to the fact that the pendulum requires re-setting; but it would be more satisfactory if the record were made, as in Professor Marvin's seismoscope, on a revolving drum, the rate of which is not interfered with by any but a very strong shock.

On account of the delicacy of Dr. Agamennone's seismoscope, it is necessary to exercise some care in the choice of a site. It should be placed at least in a room on the ground floor, but better still in a cellar at some distance from a frequented street. The most satisfactory foundation would be one of stone sunk in the ground below and entirely disconnected from the cellar floor. It should also be covered by a glass shade, in order to protect it from currents of air or other accidents.

Photograph of the Sun.

October 22nd, 1905.

THE accompanying photograph was taken with an ordinary $4\frac{3}{8}$-inch astronomical refractor telescope. It is enlarged three diameters from the original negative, which was obtained with a power of 40 on the telescope. A yellow isochromatic screen was used, and the exposure $\frac{1}{100}$dth second on a Cadett lantern plate. The photograph shows the large group of spots (which was visible to the naked eye in October) nearing the sun's western limb, and another large spot surrounded by faculæ just coming into sight on the eastern limb. The photograph was taken by Mr. E. W. Barlow, F.R.A.S., of Bournemouth.

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The Venom of Spiders.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

SPIDERS have gained an evil and frequently undeserved reputation as venomous enemies of man, and certain species are still regarded by the natives in some parts of Africa with as much horror as poisonous snakes.

We find numerous references in ancient and mediæval writers, *e.g.*, in Aristotle's Natural History, to the deadly effects caused by the bite of spiders, and the facts eventually became so exaggerated and distorted, that many writers in the last century went to the other extreme and ridiculed the idea of any spider producing injurious results in man.

It is only within the last two or three years that the question has been investigated by scientific methods, and that we have been able to form an opinion as to what amount of truth there was in the old conflicting accounts that have come down to us.

Leeuwenhoek appears to have been the first to give an exact description of the poison fangs of the spider, and his account, published in the Transactions of the Royal Society for 1702 (Vol XXII., p. 867), opens in the following quaint terms :—"I have often heard speak of the Sting of a Spider and that with the same he is able to kill a Toad, but having never learned whereabout this Sting grew, I fancied it in the Tail as it happens in most Flying Insects."

He then goes on to describe how a frog bitten by a spider died within an hour, whereas a second frog bitten by another spider was not affected in the slightest degree. In explanation of this, he suggests : "Now 'tis possible that the Stinging of Spiders in hotter Countries may be more pernicious than in our Climate ; 'tis also possible that this Spider might have spent his Poyson lately by wounding another Spider or any other Creature." Professor Kobert's investigations (*infra*), doubtless supply the true explanation of the difference, which was probably that the spiders belonged to different species.

In a later volume of the Transactions (1726), there is a letter from a Dr. Robie in New England, giving an account of the serious illness of a man who had been bitten in the leg by a small, black spider, but was better after 24 hours.

All the early Italian scientific writers contain accounts of cases that had come under their observation. Dr. Silvio Boccone (*Museo di Fisica*, 1697) describes numerous instances where illness had been caused through the bite of the malmignatte in Corsica.

Fontana, writing in 1781 on viper poison, mentions that the bite of a certain kind of spider might be fatal; and Dr. Luigi Toti gives a full description of the symptoms of 17 cases that he had himself attended prior to 1794. Of these 15 recovered after a few days, one was only saved with difficulty, and one died. The effects are described as being exactly similar to those caused by the bite of a viper. He himself was bitten by four of the little malmignattes, which had just been hatched. There was some inflammation in the vicinity of the bites but no general symptoms.

Cauro (1833), confirmed Toti's statement as to the effects of the bite of the malmignatte resembling those produced by viper venom. He stated that the natives of Corsica used a secret remedy, which he found to consist of a mixture of opium and camphor, and to be very effective.

The spider to which all these Italian writers refer is the *Lathrodectes tredecimguttatus*, popularly known as the malmignatte. It is about a third of an inch in size, and is characterised by the red spots on its black body. Another European spider belonging to the same family is the *Lathrodectes conglobatus*, which is found in Greece. It is smaller than the malmignatte and has white spots instead of red. The Russian species (*L. erebus*), known as the kara-kurte (black wolf), is common in South Russia and Turkestan, where it is a great object of dread. It is jet black, and without any spots.

Species of spiders belonging to the same family are also found in America (*L. mactans*), and in Australia (*L. scelio*, "*Katipo*," and *L. Haseltii*), all of which are reported to produce symptoms similar to those caused by the bite of the European and Asiatic species. Both the Australian species have red spots on a black ground.

According to Vinson (*Araneides des Iles de la Reunion et Madagascar*, 1863), the natives of Madagascar are in deadly terror of *Lathrodectes menavodi*, which resembles the Italian malmignatte in size and appearance, but have not the slightest fear of an allied black species. This is cited by Dr. Laboulbene (*Dict. des Sciences Médicales*) as a proof of the great exaggeration of the effects of the malmignatte bite, and he attributes the fear of the natives solely to the more ferocious aspect of *L. menavodi*. The answer to this contention is supplied by Dr. Kobert's results.

Walckenau, in 1837, made some of the largest spiders to be found near Paris bite him, and never experienced the slightest ill effects. Similar experiments were made about the same time by Duges in the South of France, but the most serious result was a slight inflammation.

Blackwall, the great authority on British spiders, published the results of his experiments in the *Transactions of the Linnean Society* for 1855 (Vol. XXI., p. 31). He found that no ill effects were produced upon himself by the bite of various spiders, including the garden spider (*Aranea diademata*), and that even insects were not affected by the venom injected by the fangs of the spiders. He asserted that "the serious and sometimes fatal consequences which have been attributed to the bite of the malmignatte must be regarded as amusing fictions in the natural history of the *Araneidea*."

The French naturalist, Dufour (1864), also came to the conclusion that the danger of the bite of the spider was to a large extent imaginary.

The question remained in this state of uncertainty until, in 1901, Dr. Robert Kobert published an excellent monograph dealing with the whole subject. He obtained recent data of cases of bites, and did an immense amount of experimental work with spiders of different species, notably the Russian kara-kurte (*L. erebus*). Detailed reports were sent to him of 22 cases admitted to the hospitals in the Chersonese during 1888. In each instance the bite had felt like a bee sting, and there was usually no swelling around the place, but soon violent pains were felt in the limbs, and this was succeeded by difficulty in breathing and cold perspirations, both the heart and central nervous system usually being affected. Recovery was generally complete after five days.

Dr. Kobert made extracts from the crushed fresh or dried bodies of these spiders, by means of a dilute solution of salt, and thus obtained solutions that were extremely poisonous, producing all the symptoms attributed to the bites.

The poison was not confined to the glands, for ex-

tracts from the legs or the abdomen proved just as venomous as those made from the chephalo-thorax. New-born spiders were more venomous than adults, and the cocoons and eggs more venomous still.

Extracts from the dreaded tarantula were found to be quite innocuous, and this was also the case with all the other families of spiders examined, with the exception of the common garden spider (*Aranea diademata* [*Epeira diadema*]), which yielded extracts producing very similar toxic effects. Both caused paralysis of the respiratory system and heart, accelerated the coagulation of the blood, and had a strong solvent (hæmolytic) action upon the red blood corpuscles.

The fact that all parts of these spiders were poisonous is analogous to what has been observed in the case of snake venom, which is not confined to the poison glands alone, for it has been proved that the blood of poisonous snakes is also venomous.

Dr. Kobert also confirmed Toti's statement that the venom is harmless when swallowed, and this is another point in which it resembles snake venom.

He further succeeded in rendering animals immune against the venom by inoculating them with gradually increasing doses, and their immunised serum conferred protection on other animals.

Both the lathrodectes poison and the poison of the garden spider were destroyed by heating them at a comparatively low temperature, and by the addition of alcohol, but the former was somewhat more stable than the latter.

Dr. Kobert concluded that both were of the nature of "toxalbumins," i.e., substances resembling white of egg in chemical composition, but possessing toxic powers.

Many poisons, however, including snake venom, which were formerly regarded as toxalbumins, have been found when properly purified to be free from albuminous substances, and doubtless this will be found to be also the case with spider venom.

(*To be continued.*)

Consumption of Tobacco.

IN the Department of Commerce of the United States some statistics have been drawn up regarding the consumption of tobacco during recent years per head of population in different countries. The following are the results:—

Belgium	2,817	grammes.
United States	2,389	,,
Germany	1,560	,,
Austria	1,370	,,
Canada	1,243	,,
Australia	1,175	,,
Hungary	1,098	,,
France	980	,,
United Kingdom	885	,,
Russia	499	,,
Italy	476	,,

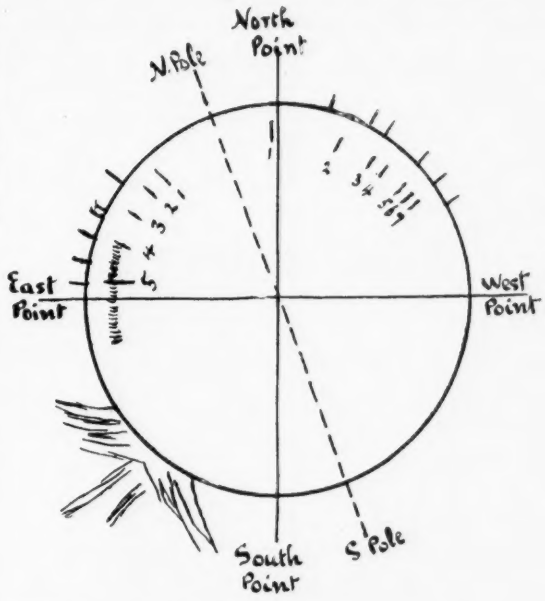
This is almost in the inverse order of the amount of taxation on tobacco.

ROYAL INSTITUTION.—A Christmas Course of Lectures, adapted to a juvenile auditory, will be delivered at the Royal Institution by Professor Herbert Hall Turner, D.Sc., F.R.S., on "Astronomy." The dates of the Lectures are December 28, 30, 1905, January 2, 4, 6, and 9, 1906, at three o'clock.

CORRESPONDENCE.

TO THE EDITORS OF "KNOWLEDGE."

GENTLEMEN,—In the three accounts of the recent eclipse published in "KNOWLEDGE" last month, there are considerable discrepancies as regards the position of the two groups of prominences. It is with extreme reluctance that I venture to differ from so eminent an observer as M. Moye. But my observations, aided by a telescope, were made very carefully, and I saw no prominence, much less a group, in the southern hemisphere. I send a diagram which shows outside the circle twelve prominences marked at the telescope. One is double-stemmed, and one is floating. Within the circle I have marked those shown in Fr. Cortie's six photographs, done at



the same time and place. The agreement is substantially exact. In the N.-E. quadrant, No. 5 was of very great height. Though it appeared the first, it is visible in the last of the photographs, taken at the very end of totality. On both sides of No. 5 there is a long blur of light in the first photograph, like the elevation of that length of the sierra. This was not noticeable in the telescope, probably owing to the very pale tint of the chromosphere and prominences.

My eye-piece was divided by spider threads into quadrants, and the north point approximately fixed by running sunspots along the horizontal wire.

Yours faithfully,
AUGUSTIN MORFORD.

The Friary, Saltash, Cornwall,
November 8, 1905.

[In our article in the October number occurs the sentence, "Photographs alone can give us the true position and dimensions of the prominences," and these eye sketches, valuable as they are in many respects, must give way before the incontrovertible evidence of the photographic plate.—ED.]

Answers to Correspondents.

Gamma. The white-hot part of a coal fire is at a temperature of over 2500° Fahrenheit, though in an ordinary domestic fire it seldom attains a real white heat. A dull red-heat is about 1200° F.

Rev. M. McLean. This was the aurora borealis, described on p. 293. It is very rarely seen so distinctly in England.

XUM

Photography

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Distortion with Focal-Plane Shutters.—It has often been pointed out that an exposure made by passing a slit opening over the face of the sensitive plate must lead to a distorted image of a moving object, because the various strips of the object corresponding to the slit opening are photographed consecutively as the object moves. This is so obviously the case that it is surprising to find the statement met with answers to the effect that if distortion exists it is negligible because it is rarely discernible. Whether or not distortion is visible must depend very largely upon the eye of the person who looks for it, and upon the character of the object distorted. A critically-trained eye can see what ordinary observers never will be able to see, and there are some distortions that cannot be detected unless the object, or an undistorted image of it, is available for comparison. A short, broad person, for example, may be improved in appearance by having his height increased or his breadth diminished by twenty per cent.

Some excellent examples of distortion with focal-plane shutters will be found in the current volume of the "British Journal of Photography" at page 807 *et seq.* Here may be seen motor cars all out of shape, and photographs of a rotating white strip or lath which do not suggest the object photographed at all. At page 858, Mr. C. Welborne Piper gives two photographs of a riding bicyclist. In one the man is slight and the wheel-base of his machine short, in the other the man is stout and the wheel-base long, and the wheels are distorted in both. It must not be concluded from these examples that focal-plane shutters are useless instruments, but rather that they should always be avoided when a shutter at the lens diaphragm, or as near to it as possible, will do the work. It is certainly true that with a focal-plane shutter the lens acts with practically its full aperture all the time, but the advantage of this has been very much over-rated. Many who lay so much stress on it probably never knew the rate of movement or the equivalent exposure given by any of their shutters in any of their exposures. A record of a movement that requires an exposure of less than the two hundredth or three hundredth of a second can often be obtained only by means of a focal-plane shutter. The resulting distorted image may be sufficient record as it stands, or it may be possible to eliminate the distortion by redrawing it, if the constants of the shutter are known.

Is Development a Reversible Reaction?—In the October number of this journal I referred to a paper on this subject by Mr. S. E. Sheppard, published in the Chemical Society's Journal for August, and remarked that in using the word "reversible" the author does not appear to consider the difference between developable and non-developable silver bromide. I said "the silver bromide is reduced by the developer because it is in the developable condition, undevelopable silver bromide not being reduced under the same conditions. When the reaction is reversed, the resulting silver bromide would, I suppose, not be likely to be in the developable state." In answer to this Mr. Sheppard writes as follows.—

"In the October issue of your journal, Mr. Chapman Jones, in referring to a paper of mine on the reversibility of photographic development (*Journ. Chem. Soc.*—Sept. 1905) criticises the application of the term 'reversible' to this reaction on the ground that the silver bromide reduced by the developer is in a 'developable' condition, due to the action of light, whilst that reformed by the reverse reaction to development is presumably not so. The phrase 'developable silver bromide' can hardly be said to express any exact conception, since with a reducing agent of sufficient potential silver bromide, either alone or emulsified, can be reduced to silver without any previous exposure. If, however, we take it to mean in this case, reduction by the ordinary developing agents of practice, Mr. Jones' criticism still fails to hold, as the silver bromide reformed by the reverse 'bleaching' action is 'developable' forthwith and without any preliminary exposure to light, a fact in agreement with photographic practice in intensification by redevelopment (*cf.* Messrs. C. W. Piper and D. J. Carnegie, *Amateur Photographer* for June, 1905). The real point at issue is, of course, the nature of the so-called 'latent image' formed by light, but this question, however interesting, cannot be dealt with in a brief letter."

It has long been known that the reaction between ferrous oxalate and silver bromide is reversible. For more than twenty years practical advantage has been taken of this fact in the use of ferric oxalate to thin or dissolve away a part of the silver from a negative that is too dense. It may be objected that no alkaline bromide is added in this case, but that does not affect the essence of the reaction. Mr. Sheppard has determined the conditions of equilibrium, including the effects of alkaline bromide and dilution. In doing this he claims to have "shown experimentally that development is a *reversible* chemical reaction" (quoted from his abstract of his paper in the Proceedings of the Chemical Society).

I cannot see that he has done anything towards proving *development* to be a reversible reaction. Development and simple reduction of the silver salt must be distinguished. A reagent that will reduce silver bromide will not, therefore, develop an image. Silver bromide exists in the developable and the non-developable conditions, although it is reducible to the metal in both conditions. Mr. Sheppard says that "'developable silver bromide' can hardly be said to express any exact conception," but this has nothing to do with the matter. We are dealing not with conceptions but with facts. The difference between developable and non-developable silver bromide is a fact, it is more than the chief corner stone of photography, it is the very foundation of it, and conceptions, exact or otherwise, do not affect it. It is just in this that the difference exists between simple reduction from a chemical point of view and development from a photographic point of view, and so far as I can see Mr. Sheppard has not gone beyond the simple chemistry.

But suppose for a moment that Mr. Sheppard had proved development with ferrous oxalate to be a reversible change, he would not have proved development in general to be reversible, because ferrous oxalate is a developer by itself, and, as a matter of practical fact, is now very rarely used. There are many developers of quite a different character (chemically considered) and, perhaps, different in their action as developers. Probably the most simple of these is hydroquinone (or quinol). Of this Mr. Sheppard himself says "this reverse reaction is largely nullified by the presence of alkali and alkali sulphite, always used with organic developers, as these substances alone or mixed react with the quinone, reducing it to quinol." So there seems to be a difficulty here, even with so simple a substance as hydroquinone, in proving development to be reversible—a difficulty that Mr. Sheppard has not overcome. And even if development with both ferrous oxalate and hydroquinone were proved to be reversible changes, it would not necessarily follow that develop-

ment with other reagents is also reversible, as hydroquinone has marked peculiarities.

Mr. Sheppard's reference to the use of the word "development" by Messrs. C. W. Piper and D. J. Carnegie is beside the mark. This word is in common use and has many applications. We talk of "developing" a carbon print when we merely wash away the soluble gelatine from it with water; we "develop" a platinum print when we bring about a simple chemical reaction; an essay writer "develops" his subject; and an athlete "develops" his muscles. In the "redevelopment" referred to there does not appear to be any distinction between developable and non-developable silver salt—it seems to be rather a simple case of removing the halogen from its silver compound.

A New Tripod.—The limitations of the ordinary tripod are all too well known by those whose work requires the camera to be supported in other than an approximately horizontal position or in places where the ground is steep and irregular. These difficulties are practically overcome in Butler's "Swingcam" camera stand. The wonderful adjustability of this stand is obtained by attaching each leg to the tripod top by means of side links and a swivel block. In replacing a single movement by three separate movements a loss of rigidity might be expected, but the adjusting screws so clamp the whole of the moveable parts together that the maker claims an increase rather than a loss of stability. Further conveniences in connection with the stand are extending bars which will raise its height to over seven feet, and swivel points to the legs, so that the points may be fixed vertically to obviate slipping when the legs are unduly splayed out. These points may even be bent up and converted into hooks, so that, for example, one leg may be secured to a convenient object above the camera, such as the branch of a tree. It is impossible to describe all the ways in which the stand may be used.

The Thornton-Pickard Company send us the list of winners of the £100 Competition for pictures taken with their cameras. The numerous prizes range from £10 to £2.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

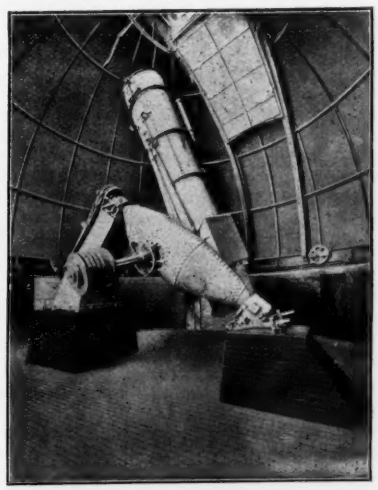
The Newly Mounted Three-Foot Crossley Reflector.

THIS fine instrument, which was first erected at the Lick Observatory in 1895, has been almost entirely remodelled according to designs of the astronomers there. Although much excellent work was done with it in its original condition, it was found that many details were unsatisfactory for the prosecution of the delicate investigations which the late Director Keeler had proposed to devote its great light-gathering power. From the extremely promising records obtained it was thought that the great value of its excellent parabolic mirror in astronomical photography emphasised the desirability of supplying it with a more rigid and efficient mounting than the one comprised in the original bequest. This was authorised by the Board of Regents in 1902, and after much consideration it was decided to adopt the form shown in the illustration. The heavy parts of the mounting were built by the Fulton Engine Works of Los Angeles, while the driving clock, slow motions, guiding mechanism, and all small parts were constructed in the Lick Observatory repairing shops.

The polar axis is of heavy boiler steel, furnished with steel jackets shrunk on to form the bearing surfaces. The declination axis is a heavy shaft of solid steel passing through the centre of the polar axis. One end carries the tube of the telescope, the other the usual counter-balancing weights.

The tube consists of a cubical central section of castings, with cylindrical sections above and below the cube to carry the eyepiece and large mirror respectively. The upper end section can be rotated for adjustments in position angle. The total weight of the moving parts is about 6 tons, and although somewhat cumbersome has the important advantage that it allows of passing the meridian in all positions without reversal.

As the driving mechanism had to be very delicate, the driving sector was made large, with radius of eight feet, the worm having a pitch of one-tenth of an inch, and as a complete driving wheel of this size would have been too unwieldy, two sectors were provided, so that one could always be ready for gearing up as soon as the other was running out. Each sector will run for 66 minutes.



In connection with the optical arrangements important modifications have been introduced. The ordinary method with Newtonian reflectors of throwing the image out at the side of the tube by a plane mirror placed diagonally has been discarded, and the plate holder fixed in the centre of the tube so that the plate is in the direct optical axis of the large parabolic mirror, and of course it cuts off in this position no more, or probably less, light than did the original diagonal mirror.

The adoption of this system then rendered it necessary to bring the screw adjustments of the plate holder to the side of the tube, and this has been done along one of the thin plates which hold the plate carrier. By means of a small reflecting prism the guiding star at the side of the photographic plate is also viewed by a subsidiary telescope at the side of the tube.

On account of the old difficulties special precautions were taken in designing the mirror cell and supports, and it is very satisfactory to find that Professor Perrine reports that the whole is very satisfactory after several months of use. The focus of the instrument can be determined easily to 0·005 inch, and it does not appear to change greatly with variations of temperature. No change of focus has yet been detected in a range of less than 10° F. Evidence of the great efficiency of the instrument is afforded by the splendid success achieved by Professor Perrine in his recent important discoveries of the VI. and VII. satellites of Jupiter in the earlier part of the present year.

XUM

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Coffees without Caffeine.

THE alkaloid caffeine, to which tea and coffee owe their stimulating property, crystallises in glistening white needles, which melt at a relatively high temperature, and can be sublimed unchanged. Tea contains some 3 or 4 per cent. of this alkaloid, and coffee about 1½ per cent., while it is also present in maté, or Paraguay tea, and guaraná, a beverage prepared by the natives of Brazil from the seeds of *Paullinia sorbilis*. M. G. Bertrand discovered four years ago that a species of coffee, *Coffea humblotiana*, growing in Madagascar, was quite free from caffeine, although containing a bitter principle to which he gave the name *cafamarine*. Since then he has found several other species of the coffee plant to contain only a small proportion of caffeine, and quite recently has examined three new species which were absolutely free from the alkaloid, but contained a bitter substance analogous to that occurring in *C. humblotiana*. All of these coffee plants devoid of caffeine grow either in Madagascar or the neighbouring islands, and are not found on the African continent. In order to determine whether the soil or climate had any immediate influence upon the development of caffeine, experiments were made with the ordinary coffee plant, *C. arabica*, but the plants grown in Madagascar invariably yielded the normal proportion of alkaloid.

The Cultivation of Plants on Radio-Active Soil.

Some extremely interesting experiments have been made by M. A. v. Poehl to determine the effect of cultivating pharmaceutical plants at Tsarkoie-Selo, near St. Petersburg, where the soil contains argillaceous schists, which, as is well known, are radio-active. The plants were examined after a year, and were found to contain radium, which, however, was only present in the roots and stalks, and never in the flowers.

The Utilisation of Natural Gas.

Natural gas is found in constant association with petroleum, but has hitherto been put to but little use, at all events in Europe. In Boryslaw, for instance, it is particularly plentiful, but is for the most part allowed to escape into the air, with the exception of the small quantity used for heating the vessels in which the crude petroleum is distilled. In America, however, it is used as the source of a gas black for printing ink, for the illumination of houses, to which it is supplied under a pressure of half an atmosphere, and as fuel for glass-works and other factories which have been built near the sources of supply. In this country the natural gas discovered at Heathfield, in Sussex, is collected and used for lighting the houses. The possibility of many new applications of natural gas is suggested by the fact that Herr Wolski has taken out a patent in Austria for its liquefaction, and that the process has been found a success in the Carpathian oil fields. The liquefied gas begins to distil at about 106° C., and the first fraction consists in the main of the hydrocarbon methane. The vapour tension of the liquid is relatively very small, and the product can therefore be safely kept or transported in ordinary soda-water syphons. It seems likely to have a great future before it for such purposes as lighting isolated houses and driving small gas-engines and motors, whilst being a bye-product of the petroleum industry its cost will be much less than that of ordinary coal gas.

A New Ferment.

There are many species of yeast, but until recently none was known that was capable of resisting a high temperature. Messrs. Johnson and Hare, however, have separated from eucalyptus leaves a new species possessing this characteristic in a high degree, being able to convert sugar into alcohol at a temperature of over 105° F., which would be fatal to ordinary yeasts. At the end of the fermentation the new yeast, to which has been given the name of *Saccharomyces thermantitonum*, falls to the bottom of the vessel in a compact agglutinated mass. The cells are more oval and rather smaller than those of the more common saccharomyces, and have several other distinguishing features. The use of this ferment has been protected by 55 patents in different parts of the world, for its great commercial value is due to the fact that by its means fermentations can be carried on in tropical countries, where hitherto this was out of the question. A further advantage is that it is possible by simply heating the cultivations to destroy foreign micro-organisms without injuring the yeast. It is so resistant to heat that it can withstand for a short time a temperature of 170° F. Even after the cells have been killed by being submerged in water at 176° F., the active agent or enzyme they contain is still capable of producing a weak fermentation.

Sympathetic Inks.

Sympathetic inks are commonly regarded as chemical toys, although the fact that several recent patents for such inks have been taken out shows that they have practical uses of commercial value. One of the earliest means of writing in characters that were nearly invisible until warmed was milk, the use of which was recommended by Ovid, whilst Pliny makes mention of various plants whose juices were suitable for the same purpose. Numerous references to secret inks occur in mediæval writings, but we can only make a guess as to their composition. Brossonius, writing in a medical treatise in the earlier part of the 17th century, describes a "magnetic fluid," prepared from "arseniated liver of sulphur," only visible when looked at "with the eyes of affection." This appears to have been nothing more than a solution of lead acetate, the characters being rendered visible by the action of sulphuretted hydrogen. This lead acetate ink is described by several other early writers, and notably by Otto Tachen (1669), who points out that there is nothing magnetic or miraculous in its action. It was described as "sympathetic ink" by Le Mort, and the name was afterwards extended to all preparations suitable for secret writing. The curious behaviour of salts of cobalt when heated was first described by Waiz in 1715, and solutions of one or other of these have since formed the basis of many of the so-called sympathetic inks. Cobalt chloride, for instance, is pink in the crystalline condition, but when heated loses water and becomes blue. Characters written with a solution of this salt are nearly invisible on white paper, but turn blue with heat, and then gradually absorb moisture from the air becoming pink again, and practically disappearing. In the case of some other substances a re-agent is required to develop the writing. Thus characters written with gall extract turn black on treatment with an iron salt; gold chloride gives purple writing with tin chloride, and starch gives a blue coloration with iodine. The last-named ink has long been a favourite with sharpers of the racecourse, two of whom were last year convicted of the fraud. A betting paper giving the names of the horses is written in two kinds of ink, one of which speedily fades away, while the other gradually appears. The disappearing ink is often a weak solution of iodine tinged with starch, and the characters written with this soon fade. For the invisible writing a favourite ink is a solution of silver nitrate, which darkens under the influence of light. An ingenious application of a sympathetic ink, patented by Kromer, insures the detection of any tampering with an envelope. The dry constituents of the ink, *e.g.*, tannin and iron sulphate, are separated by means of the adhesive gum, so that should steam be used to open the envelope they come into contact and leave a stain upon the paper. A sympathetic method might be based upon the fluorescence of quinine salts under ultra-violet light, or of other compounds when exposed to the rays of radium, &c.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

"Wash-Outs" in Coal-Seams.

THE subject of "wash-outs" occurring in some of the middle coal-measures of South Yorkshire has been dealt with by Mr. F. E. Middleton, F.G.S., in a paper recently published in the Quarterly Journal of the Geological Society. He is of opinion that they occupy the sites of winding streams, which meandered through the alluvial tracts in which the coal-seams were being formed. This would account for breaks in the continuity of the deposition of certain seams, but true wash-outs

would be those which were attributable to subsequent denudation of seams as originally formed. In the Eureka seam in Netherseal Colliery (South Derbyshire Coalfield) the wash-out, instead of being one broad hollow, consisted of numerous confluent streams, and these united together to form a main channel, like the head-waters of a drainage system. Mr. Middleton points out that in the Barnsley seam denudation has been found over an area 1700 yards in length from east to west, and in the Parkgate seam (240 yards below) over an area 2600 yards long from north to south. Although the wash-out in neither case was completely crossed, the width, it is thought, could not be less than 600 yards.

The Genus Glossopteris.

The question of the true affinities of the genus *Glossopteris* at present remains an open one. As a rule, it is classed with the Filicales, but this classification can only be regarded as a convenience, and must not be regarded as finite. 'Minute organs, elliptical in shape, have been in close association with *Glossopteris Browniana*, in specimens from New South Wales, which Mr. E. A. N. Arber, F.G.S., F.L.S., thinks are not unlike the sporangia of certain recent and extinct ferns and cycads. There is, however, no trustworthy evidence as to their contents. That they may be attributed to this genus is indicated by the fact that they have never been found except in the closest association with the scale-leaves of *Glossopteris*, whilst some of the scale-fronds show scars of attachment and fragments of sac-like bodies still apparently in continuity. A close analogy may perhaps be found, Mr. Arber thinks, in the micro-sporangia of cycads.

Tertiary Limestone at Belmont Hill.

In reference to the white tertiary limestone from Herne Hill, to which I recently referred, my attention has been called to some hard flinty "race" which was found this year at the base of the *cyrena* Shell-bed (Woolwich series), about 12 feet from the surface, at Belmont Hill, Blackheath. This has been analyzed by Mr. H. Dixon Hewitt, for the Geologists' Association, with the following result:—

Calcium carbonate ($CaCO_3$)	94·7
Magnesium carbonate ($MgCO_3$) . . .	0·7
Iron and Aluminium Oxides ($Al_2O_3 + Fe_2O_3$) .	3·0
Sand and Clay	0·6
Combined Water, traces of Alkalis, Phosphates, &c. (by difference)	1·0
	100·0

Submerged Coast-Lines.

At the opening meeting of the Geological Society of London on November 17, an important paper on "The Coast-Ledges in the S.W. of Cape Colony" was read by Prof. E. H. L. Schwartz. Similar coast shelves have there been found to those which characterise both the European and American sides of the North Atlantic. The most striking of these remarkable coast-shelves is said to be the Upland Shelf, extending from Caledon to Port Elizabeth. It is cut by deep gorges into narrow ridges or "ruggens," but at a height the level tops of these ridges can be observed. The surface is in places covered with superficial deposits, cemented boulder-deposits, gravels, and sandy clays, hardened at the surface into ironstone or freshwater quartzite. Prof. Schwartz considers that this shelf cannot have been formed as a peneplain, but by marine denudation. On the 150 to 200 feet plateau there are deposits with marine shells, and in a depression on its top the evaporation of rain-water produces a large quantity of salt. The rock-shelf under the Cape Flats appears also to have been cut by the sea. The Agulhas Bank seems to consist of a succession of ledges, but it is not known whether further shelves extend beyond its margin. Taking the ledges together, the continent would appear to have been subject to lifts of 600 or 700 feet, with intermediate halts and setbacks.

What is the Thirpole?

We all know Cuvier's *Palæotherium*, or "ancient wild beast" of the Paris basin, but what are we to understand by the name "Thirpole," to which Dr. W. Martin, of Lincoln's Inn, refers in the following communication? It will be seen that he suggests that the two names are of identical origin. He says: "What is the fish called *Thirpole* that is alluded to in the following quotation from Staunford's 'Exposition of the Kinge's Prerogative' (edition 1577)? 'So in Bracton's time it was doubted by the common lawe, whether the King should have this great fish called *Thirpole* wholly or not. And so likewise in Britton's time, as it may appear in his book fo. 27, which now this statute hath made clear and without question.' I cannot find any reference to this fish either in Bracton, in Britton, nor in the statute to which allusion is made. Possibly *Thirpole* was a word newly coined by Staunford from the Greek words θηρ, a monster, and παλαιός, ancient, venerable, and was meant to be equivalent to 'that leviathan,' about which so much was heard, but which was never seen. I may mention that whales, sturgeons, and possibly porpoises, were considered, when caught within seas that were part of the realm, the property of the sovereign or his consort, and were consequently called 'Royal Fish.'"

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Duration of Life Among Birds.

WHEN we consider the great numbers of those who are interested in birds, it is strange that there should have been so little recorded as to the age to which birds live.

Parrots are proverbially long-lived, and most of us are familiar with the story of the venerable bird which Humboldt met with in South America. Though voluble enough none could understand it, as it spoke the language of a tribe of Indians—Atures—which had long become extinct.

Weissman mentions a white-headed vulture which died in the Zoological Gardens at Vienna in 1824 after 118 years of captivity. Ravens are said to have lived 100 years in confinement, while canaries and linnets may live from 10 to 18 years.

The latest contribution to this subject will be found in an extremely interesting article by Lady Ingram in the *Windsor Magazine* for November. Herein will be found many curious and not a few really valuable facts, especially with regard to the question at issue. Thus white birds are generally supposed to be less robust than more normally coloured, yet a white sparrow whose life history is described in this article has lived 13 years in confinement, and during this time has reared no fewer than 12 broods! Though this bird is still in good health it appears, however, to be showing signs of age.

Hoopoe in Inverness-shire.

The *Field*, November 11, records the fact that a hoopoe was shot at Onich, Inverness-shire, during the first week in November. It had, unfortunately, been hovering about the neighbourhood for some days, and had been kept under observation by one or two well-wishers, only to fall a victim at last.

Breeding of Common Kite in Wales.

Owing to the action of the British Ornithologists Club, aided by the kindly co-operation of Earl Cawdor and Dr. Salter, the last remnant of the kites in Wales were this year enabled to rear their young unmolested; two pairs succeeding in bringing off two young each. It is believed that no young kites have been reared in Wales for at least 10 years past.

Breeding of the Bower-Bird in Confinement.

Mr. Reginald Phillipps is to be congratulated in that the Regent bower-birds (*Sericulus melinus*) in his aviaries have this year succeeded in rearing young. Two birds were hatched, the first on August 6, the other two days later; by August 22 both birds had left the nest, having, it is to be noted, well-developed wings, but scantily covered bodies. Unfortunately one of these birds was killed during September, apparently by swallowing the shoots of an elder tree; but the other bird is now full grown and hardly distinguishable from the female. The period of incubation appears to be nineteen or twenty days. This is the first record, we believe, of the breeding of these birds in confinement.

XUM

A New British Shrike.

At the meeting of the British Ornithologists Club held on October 18, Mr. M. J. Nicoll exhibited a fine male adult specimen of *Lanius nubicus*, which had been killed at Woodchurch, Kent, on July 11, 1905.

Black-eared Chat in Sussex.

At the meeting of the Ornithologists Club just referred to, Mr. M. Nicoll also exhibited a black-eared chat (*Saxicola stapazina*), which had been killed at Pett, in Sussex, on September 9. This bird, Mr. Nicoll pointed out, belonged to the Eastern form of the species, having the underside of the wing and the axillaries jet black. The two previous occurrences of the black-eared chat in these islands were both of the Western form (*Saxicola catarinæ*).

Aquatic Warbler in Sussex.

Mr. Nicoll also exhibited at this meeting an aquatic warbler (*Acrocephalus aquaticus*) which he had shot at Rye, Sussex, on August 18 of this year, and reported that during the day he saw about half-a-dozen of these birds in one large reed-bed.

Aquatic Warbler in Hampshire.

Mr. H. F. Witherby exhibited at the meeting of the Club just referred to, an aquatic warbler which had been taken on St. Catherine's Lighthouse, Isle of Wight, on September 29 last. The bird was an immature female, and made the third record of this species in the county.

Icterine Warbler in Hampshire.

Mr. Witherby exhibited, with the aquatic warbler, an immature female of the icterine warbler (*Hypolais icterina*). This bird had also been taken on St. Catherine's Lighthouse at the same time as the aquatic warbler, and was the first recorded instance of the occurrence of this species in the county of Hampshire.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

Emission of Corpuscles in the Dark.

IT is well known that the alkali metals give out negative corpuscles (*i.e.*, electrons) when exposed to light, even when this is of very feeble intensity. Thus in the case of sodium or potassium or their liquid alloy, Elster and Geitel found that a negative charge was dissipated by the light from a petroleum lamp; while from the still more electro-positive metal rubidium negative electricity could be discharged by the light from a glass rod just heated to redness. The order of the metals for this effect is the same as the order in Volta's series for contact electricity.

Professor J. J. Thomson has now shown that, with the metals mentioned, there is a small emission of corpuscles, even when all external light is excluded. An electroscope is placed in a bulb, which can be very highly exhausted by means of charcoal cooled to a very low temperature—the brilliant device of Sir James Dewar for very rapidly producing exceedingly high vacua. Clean rubidium or K-Na alloy is placed below the gold leaves, and the metal is earthed. The whole is placed in a light-tight case, no light being admitted except a momentary illumination through a red glass window for the purpose of reading the deflection of the leaves. Even this momentary illumination produced a slight leak, which can, however, be separated from the true leak by the fact that the latter is proportional to the interval between the readings, whereas the former is independent of this interval.

When the leaves of the electroscope were charged with *positive* electrification, there was always, even in the dark, a small leak of electricity, while there was no leak when the leaves were *negatively* charged. The leak apparent in the former case is attributed to negative corpuscles leaving the alkaline metal and settling on the leaves. This is proved by the fact that when the bulb is placed in a transverse magnetic field the leak stops.

The presence of a minute quantity of hydrogen in the bulb has an extraordinary influence in increasing the leak; in some cases after the admission of the hydrogen, it was made ten times as great. This increase rapidly died away, but was renewed on admitting a fresh supply of hydrogen. No increase was produced on admitting carbon dioxide.

Final Disintegration Product of Radium.

Rutherford considers that the ultimate residue after all the charged particles have been emitted by radium is lead. The atomic weight of radium is 225; five Alpha particles at least are known to be expelled during the successive changes that take place. If each of these is an atom of helium of mass 4 the residue must have an atomic weight of 205, which is exceedingly close to the atomic weight of lead. In support of this conjecture, he cites the fact that in all radio-active minerals lead is present, and its amount is roughly proportional to the helium present. This would be the case if both of them are disintegration products.

ZOOLOGICAL.

By R. LYDEKKER.

Some Fossil Reptiles.

SINCE our last column of Notes was written three papers of more than usual interest have appeared on extinct reptiles. In the first of these Mr. C. W. Gilmore has published a brief illustrated account of the complete skeleton of that most marvellous of all fossil reptiles, the great horned dinosaur (*Triceratops prorsus*) of the Cretaceous strata of Wyoming. In addition to its horns, the most extraordinary feature about this creature is the huge size of its head, with its great frill-like collar extending backwards well on to the shoulders. This is shown by the fact that while the length of the entire skeleton is 19 feet 8 inches, that of the head is no less than 6 feet, or nearly one-third the total dimension. In this respect *Triceratops* presents a strange contrast to the *Diplodocus* skeleton in the British Museum, in which the head is only about one-eightieth of the total length. Nevertheless, the horned monster was no better off in the matter of brains than its small-headed cousin.

In the second of the two memoirs Mr. L. Dollo, of the Brussels Museum, gives us the results of his investigations on the footprints of the iguanodon, based on specimens from the Wealden strata of Hastings and its neighbourhood. From a careful study of these tracks the author is enabled to tell us the approximate postures assumed by this giant dinosaur when running, walking, and at rest.

In the third and last paper Mr. Gilmore confirms the discovery that the so-called toothless American fish-lizard, *Baptanodon*, really possessed a few rudimentary teeth, thus bringing it into close relationship with *Opthalmosaurus* of the English Oolites.

The Deafness of Fishes.

Despite the fact that carp in a pond will come up to be fed at the sound of a bell, a learned German professor has arrived at the conclusion that fishes of all kinds are in all probability stone-deaf. This conclusion, startling as it may seem, is largely based on the fact that these creatures lack a certain structure in their auditory organs which the professor regards as absolutely essential to the function of hearing. Such vibrations in water as fishes are capable of perceiving are consequently believed to be transmitted by a sense compatible with our own sense of touch or feeling.

South America, Africa, and Australia.

In his recent presidential address to the Zoological Section of the British Association Mr. G. A. Boulenger, from the evidence of freshwater fishes, is disinclined to believe in a land-connection during late geological times between South America and Africa. Professor W. B. Scott, from the study of certain fossil mammals, is, on the other hand, convinced that such a connection did exist; while the examination of some supposed fossil marsupials from Patagonia leads Mr. W. J. Sinclair (who, like Prof. Scott, belongs to Princeton University) to be equally confident as to the existence of a similar

bridge between South America and Australia. With such diversity of views among "doctors" it is a little difficult for the amateur to know which lead to follow; and it is therefore satisfactory that the subject is not one involving any vital or pressing issues.

Ancestry of the Dog.

From deposits in Russia belonging to the polished stone-age Dr. T. Studer has recently described the skeleton of a large kind of dog closely allied to the domesticated species. This dog, which it is proposed to call *Canis pontiatini*, is believed to have been originally wild but subsequently domesticated by early man. In general characters it comes very close to the Australian dingo. By crossing between this species and the wolf Dr. Studer believes that other extinct species or races of dogs have arisen, and from these in turn have been developed the mastiffs on the one hand and the deerhounds on the other; and it is also presumed that the sheepdogs and hounds trace their origin directly to the same ancestral form. On the other hand terriers and Pomeranians are believed to have sprung from a totally different extinct stock. Dr. Studer may be perfectly right in these respects, but he has yet to prove that *Canis pontiatini* is a truly wild form, and not a domesticated derivative from the wolf.

A Mysterious Reptile.

In the *Transactions* of the New Zealand Institute a dignitary of the Church records some interesting information with regard to an unknown reptile supposed to inhabit the Waoku Plateau. Legends are rife as to the existence of this creature, which is said to be amphibious; and about five-and-thirty years ago an example, in a decomposing condition, is reported to have been seen by a European. A second specimen, about 18 inches long and of a yellow colour, is said to have been observed by a lake about fifty years ago. The suggestion has been made that the creature is a salamander; but, from the distribution of that group, this is highly improbable. If it be anything more than a myth, it is far more likely to be an amphibious representative of that strange reptile the New Zealand tuatera, the sole known survivor of an extinct order.

Tsetse Fly.

All that is known concerning the geographical distribution of those terrible African pests, the tsetse flies, will be found in a map accompanying the latest issue of the Royal Society's reports on the sleeping-sickness.

REVIEWS OF BOOKS.

The Microtomists' Vade-Mecum, by Arthur Bolles Lee. Sixth edition, pp. x. and 538. (J. & A. Churchill, 1905; price 15s. net).—This well-known book was first published in 1885, and the volume before us is the sixth edition, the previous edition being issued in 1900. This alone would show that the book is a useful one, but the fact is that to the worker with the microscope, whether in anatomy, or physiology, or zoology, the book has become indispensable as a work of reference. It is above all things a book for the serious worker, but the amateur, if he has the root of the matter in him, and wishes to understand the methods of preparation of objects upon which modern microscopical research is now so largely built, will find it most instructive. To the professional worker, however, it no longer needs recommendation. It represents exceptional labour in bringing together so many methods and formulæ, and not less judgment in deciding what to omit where the mass of material for selection is so great. The new edition varies from the previous one mainly in the direction of consolidation and perfecting of the arrangement of the subject matter. The old chapter on "Staining with Coal-tar Colours" is now embodied in the chapter on "Staining" generally. The chapter on "Connective Tissues" and on "Blood and Glands" appears now as two separate chapters, and they contain much new matter, having been, in fact, largely re-written. The chapters dealing with the nervous system have been re-arranged, and have received especial attention, with especial reference to new methods. The bulk of the matter deals, of course, with histological methods for man and the higher vertebrates, and one might perhaps wish that the methods for the invertebrata could be slightly extended.—F.S.S.

Methods in Microscopical Research-Vegetable Histology, by Abraham Flatters, F.R.M.S.; pp. x. and 116; 29 illustrations in the text and 22 coloured plates containing 85 figures (Sherratt and Hughes, 1905; price 21s. net).—Unlike the book reviewed above, this work is written for the elementary student, and not for the advanced worker. In fact, the title is somewhat misleading—unintentionally, no doubt—as the elementary methods in vegetable histology dealt with here can scarcely be considered as methods of research, as the term is generally understood, however suitable they may be for teaching a class of beginners their first steps in botanical histological methods. Mr. Flatters selects some half-dozen well-known fixing and preservative reagents, and a dozen or so simple stains, and explains the various processes by which a botanical specimen can be prepared for section-cutting, either by the celloidin or paraffin-infiltration methods, cut in the hand-microtome, stained and mounted. The instructions generally are based on those carried out by Mr. Flatters' class in the Manchester Municipal School of Technology, and are clear, concise, and adequate for their purpose. The accompanying letter-press is beautifully illustrated, but some of the illustrations seem to be rather superfluous—for example, an illustration of eleven ordinary hollow-ground slides of different sizes and shapes, or of twelve "rings" of different sizes for building up deep cells. The plates are devoted to illustrations of various botanical sections prepared by the above methods, with brief descriptions. They are beautifully reproduced in colours, and appear to be for the most part from photo-micrographs, and, if not differing greatly from the ordinary botanical slides sold by the better-class opticians, at least serve to show what similar slides should look like, and have a considerable educational value as well. The best of these reproductions of slides is one showing mitotic division in a longitudinal section of an onion. We are not quite sure whether the volume under review is published in the ordinary way, or is an advance copy of a work to be published by subscription, conditional on a minimum of 200 subscribers being obtained.—F.S.S.

The Uses of British Plants. Books dealing with British plants are legion, but one treating the subject from a new point of view is decidedly a novelty. It may be argued that no new idea is presented; nevertheless the information brought together was previously scattered through publications, dating from the fourth century B.C. up to the present day. The reader is introduced to many peculiar views entertained by people of past ages as to the virtues of our common wild plants from a medicinal standpoint. The etymology of both English and Latin names is instructive. Finally, the numerous figures, illustrating 288 British plants, adds to the value of the book.

Everyday Life Among the Head-hunters; and other Experiences from East to West. By Dorothy Cator, pp. xiv. and 212; illustrated (London, 1905: Longmans, Green and Co.; price, 5s. net).—Apart from "experiences" on the West Coast of Africa and elsewhere, which, although entertaining enough in their way, are of no very special interest, Mrs. Cator has given an account of some of the little-known tribes in the interior of the great Malay island which accords to her brightly written little volume a value far above what can be claimed for many works of a similar nature. And not only is the author to be congratulated on having furnished so much information with regard to these native tribes, but she is entitled to a high position among Englishwomen who have done credit to their race and country by their personal prowess and pluck. As the companion of her husband on several journeys connected with his official position into the interior of Borneo, Mrs. Cator had the opportunity of seeing tribes to whom a European was previously unknown, and from whom it was a question as to the kind of reception which would be accorded to the travellers. Fortunately, all turned out well, and the author is enabled to bear testimony to the civility with which even the most truculent of head-hunters receive strangers, and to their quiet and affectionate family life when they are not on the war-path. Gifted with an observant mind, and with the power of recording her impressions in pleasant and readable language, the author has, we think, scored a decided success in this book of travels among the head-hunters of Borneo.

XUM

Magnetic Induction in Iron and other Metals, by Professor J. A. Ewing (Electrician Publishing Office).—We have received a copy of the third edition of this classical treatise. It is a veritable *vade mecum* for the electrical engineer, or, indeed, also for the theoretical physicist. Commencing with the simplest definitions of magnetic qualities, the author extends the treatment so as to include not only directly magnetic phenomena, but also a large number of secondary effects which arise from the effects of stress. The general method followed is that of the magnetic circuit, as introduced by J. and E. Hopkinson, a method which is analogous to the electric circuit method for dealing with electric currents. By means of this method great simplification arises in the solution of problems in connection with dynamos and transformers. The chapter which will probably be found the most interesting to readers of this journal is that on "Molecular Theory," in which it is shown in detail how all the properties of a piece of iron can be imitated by a group of small pivoted magnets. When these are arranged at random the assemblage behaves like non-magnetised iron. When placed in a magnetic field a certain amount of alignment takes place amongst the small magnets; the assemblage has then all the properties of a magnet, and this is the more so as the alignment becomes more complete. The concluding chapter on "Practical Magnetic Testing" is new to this edition.

An Introduction to the Study of Colour Phenomena, by J. W. Lovibond (E. and F. N. Spon, Limited, London).—The main object of the work described in these pages was the construction of a series of glass standard colour scales, which are correlated to some physical colour constants, and by means of which a colour sensation can be measured, recorded, and reproduced at will. The author adopts coloured glasses for this purpose, and has had constructed a series of grades of glass of different tints, by comparison with which—taken singly or in combination—any colour can be classified. To physicists who are accustomed to refer all tints to a standard spectrum, specifying each by the wave-length of the light referred to, such an elaborate system of coloured glasses seems not only unnecessary, but somewhat arbitrary. The writer of this notice has seen a box of these glasses, and the standard yellow glass appeared to him to be a distinct citron-green. This in itself is, of course, no serious objection, assuming that the same standard tint can be reproducible at will. To ensure this a comparison is made with a definite thickness of the solution of some pure salt, such as copper sulphate. Although the arbitrariness of the scale of tints makes them useless for scientific purposes, it is possible that they may be of use in the identification of certain manufacturing products. We do not think, however, that their limited utility will repay the enormous labour which has evidently been spent in producing them. This small volume is beautifully illustrated by hand-coloured diagrams.

Researches on the Affinities of the Elements, by Geoffrey Martin, B.Sc., pp. xii. and 287 (London; Churchill; price, 16s. net.).—Since the days when Newlands pointed out that the elements arranged in the order of their atomic weights exhibited progressive relationships recurring at certain periods in the series, this "periodic law," as it subsequently became in the hands of Mendeljeef, has formed the basis of much of the speculation in chemical philosophy, and has borne fruit in the discovery of new elements predicted theoretically as necessary to fill gaps in the series. Mr. Martin's book also deals with certain aspects of the periodic system, and is a valuable contribution to the philosophy of chemistry. It is well known that the various elements differ in their degree of attraction for other elements, but hitherto no systematic attempt has been made to discover whether these affinities varied in accordance with any rule. Numerical data are very scanty, and consist of measurements of the heat of combination of the different elements with one another, and hence the author's conclusions have had to be based largely on qualitative differences in the readiness with which parallel compounds can be decomposed into their constituents. But after making allowances for the roughness of the method, it is shown that when the elements are arranged in their periodic order, their "affinity surfaces," when compared, assume "the positions of an advancing wave" repeating itself at the successive cycles in the system. Full directions for obtaining these geometrical representations or "affinity surfaces" are given, together with a large folding plate showing those of 14 of the more important elements. This "wave law" is illustrated by an immense amount of experimental results collected from scientific publications and arranged in tabular form. Several other conclusions are drawn from a consideration of the facts, and all are supported by very able reasoning. Unfortunately the style frequently leaves much to be desired, and the book teems with irritating misprints, in addition to the long list of errata given at the end.

Elementary Chemistry: Progressive Exercises in Experiment and Theory, by F. R. L. Wilson, M.A., and G. W. Hedley, M.A., pp. xii. and 167 (Oxford: Clarendon Press; price 3s.).—The authors state in their preface that this book is intended to train the thinking powers of the pupil rather than to fill him with chemical facts, and the series of progressive exercises and questions they have devised appears admirably adapted to carry out this aim. They begin with simple measurements involving the use of the metric system, and then deal with the construction of simple apparatus, the thermometer, the chemical balance, solution and crystallisation, the properties of liquids, and finally the identification of substances by their physical properties. In short, it would be difficult to find a more thorough or complete introduction to physical chemistry. The book is well printed on good paper, and gives clear illustrations of the apparatus described in the text.

An Intermediate Course of Mechanics, by Alfred W. Porter, B.Sc. (Murray; price 5s.). As may be gathered from the title, this book is intended for students at College Lectures, and aims at giving them a clear idea of general principles rather than fulness of details. The subjects of rectilinear translation, momentum, vectors, &c., are clearly explained, and the mathematics introduced are not too deep, as is so often the case in such text books. A chapter on the Mechanics of Fluids is added, and appendices give many examples and specimen examination papers.

The Origin and Influence of the Thoroughbred Horse (Cambridge Biological Series, 1905; pp. xvi. and 538, illustrated; price, 12s. 6d. net).—Although an archæologist in place of a naturalist by profession, the author of this well-illustrated volume is to be congratulated on having brought together a vast store of valuable information—much of which was difficult of access to the ordinary naturalist—with regard to the vexed question of the origin and distribution of our domesticated breeds of horses, and more especially the English thoroughbred and its ancestral type—the Barbs, Turks, and Arabs. It is true, indeed, that he is somewhat vague as to what constitutes a species and a sub-species, or race, and that there are numerous inconsistencies and errors in his summary of the existing forms of the *Equidæ*; but, as a matter of fact, this part of the subject has comparatively little bearing on the main thesis of his work, and, in our opinion, it would have been no loss had the greater part of this been altogether omitted.

The author's main contentions appear to be as follows. Adopting the views of previous works as to the distinctness of the thoroughbred stock from that of the horses of northern Europe and northern and central Asia, Professor Ridgeway believes in the existence of three distinct types of horse. Firstly, the Celtic type, from Iceland, the Hebrides, and other parts of north-western Europe. Secondly, the tarpan, now represented by some forms of the so-called *Equus przewalskii*, of Mongolia. And, thirdly, the North African, or Barb type, inclusive of Arabs, Turks, and the modern thoroughbred. The first two are represented by small breeds of large-headed horses, showing a marked tendency to dun-colour, with dark brown legs. From their small size, they were first broken for driving instead of riding, and, owing to their intractable disposition, were controlled by means of the bit. The Barb type, on the other hand, is represented by horses of larger size, with relatively smaller heads, and of more slender build, whose typical colour appears to be bay, frequently accompanied by white "stockings" and a white star on the forehead. Their more tractable disposition led to these horses being controlled by a nose-band in place of a bit, while from their superior size they were in the first instance broken for riding. Northern Africa is held to have been the original home of this stock, which was not introduced into Arabia till a comparatively recent date. Barbs, Turks, and finally

Arabs formed the original basis of the thoroughbred strain; but Barb stock, in the author's opinion, is also to be detected in the English Shire horse, as indeed in most of the dark-coloured breeds. With the general scope of these conclusions, most naturalists will, we think, be disposed to agree; but in regard to the place of origin of the Barb-Arabian stock, and the now extinct wild form from which it is derived (on which latter point the author is in the main discreetly silent), there may be two opinions, and the question will have to be solved by palæontological evidence. As to the value of Prof. Ridgeway's work—to those capable of reading between the lines—there can be no question.

Religion for all Mankind, by the Rev. Charles Voysey (Longmans, Green, and Co.; 1s. net). Religion, in its wide sense, is a subject usually of the most polemical nature. The believers of one pursuasion are never in agreement with the expositors of another system. Statements in the Bible and in other code books are frequently called in question by those not imbued with the sentiment that binds them to that particular creed. Yet here is propounded a religion "based on facts which are never in dispute." The tenets of the Theistic Faith have long been known, but Mr. Voysey, wisely enough from his point of view, desires to instil into the minds of his fellow-men more evidence of the reasonableness of the principles which he propounds. He keeps himself absolutely clear of all so-called "Divine Revelation" as authority, and by so doing can give offence to none. Many of the true and beautiful words of the Bible are quoted, but only as illustrations, not as a basis of belief. Compared with the dogmatic assertions of some religious writers, who, in their narrow minds, presuppose that their readers must believe every word they are told, the simple statements here given are a pleasure to read. "It is the right and duty of every man to think for himself in matters of religion," is the first article of Theistic Faith, and whatever form of religion we may happen to adhere to, we must agree that such a sentiment is perfectly correct, and this is typical of the book. We find throughout but little that can be objected to. There may be many who will not wax enthusiastic over these teachings; but, we think, all will agree that the author's words are fair and straightforward, and that to carefully peruse such a book tends to make us better men.

How to Know the Starry Heavens, by Edward Irving (Fisher Unwin; price 8s. 6d. net).—This is decidedly a good book. Its title and style are unassuming. One might have expected it to be a mere guide to the constellations, and, being by an American, one would not have been surprised had it referred to other matters entirely, but it is very much more than that. To call a small book of 300 pages a *complete* work on Astronomy would of course be a little too much, but in these pages there is very little of importance, to the man-in-the-street, that is left out. The wording is simple and explanatory, and due expression is given to the wonders described. Some pages digress, perhaps, too much into the fanciful. We are taken a trip into space "in the chariot of imagination," and, when half-way to the nearest star, we are told that "the scene is grand beyond the power of language to describe." Why it should be any grander than the view from our humble little earth on a clear night we do not know. We are then taken to visit "one of the stars." But a description follows which applies right enough to our Sun, as far as we know it. But do we know that any other star has "a glowing surface or photosphere, which has the appearance of being dotted over with still brighter specks like rice-grains"? And so on. Even the planets circling around it are in turn described. Why not call the Sun the Sun? Useful comparisons and similes are given to impress upon our mind the relative distances of heavenly bodies. It is thoroughly characteristic of the author's nationality not merely to point out that it would take 5000 years to travel by express train to Neptune, but also to add that "the railway fare, at one cent a mile, would be nearly $28,000,000—this makes a railroad impracticable!" The book is most admirably illustrated, not only by reproductions of some of the beautiful photographs now available, but also by several coloured plates.

Results of Rain, River, and Evaporation Observations made in New South Wales during 1901-2.—For many years past an annual volume containing the results of the rain, river, and evaporation observations made in New South Wales has been published, but owing to the economies recently enforced by the State Government, the volumes were suspended for some time. The results for the two years 1901 and 1902 have now been issued in one volume. Mr. H. C. Russell, F.R.S., the Government Astronomer, has been successful in getting together an army of over seventeen hundred voluntary rainfall observers. The annual volumes have become extremely valuable as so many interests are dependent upon the rainfall in the Colony. The two years 1901 and 1902 were marked by severe drought. In the year 1902 the average rainfall for the whole State was only 14·09 inches, which was the lowest average on record, with the exception of 1888, when the rainfall was 13·40 inches. The year 1888 was, however, followed by a series of years having plentiful rainfall, while 1902 on the contrary was the eighth consecutive year of drought. The drought was most intense in the western country, where dust and sand storms prevailed, caused by persistent dry winds. Sand storms proved a most destructive agent in the back country; drift sands and light dead weeds were carried over the plains until stopped by fences, where the banked-up sand formed dunes. The effect of the drought was most severely felt in the sheep-rearing industry. Mr. Russell says: "During the seven years ending 1901 the number of sheep grazing in the Western Division had dwindled from 16,000,000 to about 5,000,000. Taking into consideration the value of the sheep as a wool-producer, and the possible natural increase had there been no drought, this represents a loss to the State of at least £30,000,000. In the case of Momba Station, which is one of the largest in the State, the biggest shearing in one year was 420,000 sheep; in the year 1902 this number became reduced to 70,000." The effect of the drought is shown in a peculiar manner by the decrease in number of voluntary observers; in previous years these had shown a steady annual increase, from 96 in the year 1878 to 1719 in the year 1901, but this number fell to 1650 in the year 1902, which was brought about in a large measure by owners being compelled to temporarily abandon their homesteads.

Results of Meteorological Observations in New South Wales during 1900, 1901, and 1902.—This volume contains the daily observations made at the Sydney Observatory, and the monthly results from about fifty stations in various parts of the Colony.

Successful Negative Making, by T. Thorne Baker, F.C.S., F.R.P.S. (*Focus* office, Harp Alley; price 6d.), is a simple little book of 40 pages, which puts clearly and concisely, yet quite fully, all about dry plates, in theory and practice, exposures, and developments. It is quite a good practical guide, but would certainly have been the better for a list of contents and an index.

Pattern Making, by Joseph E. Dangerfield (Dawbarn and Ward; 6d. net), is one of those useful and thoroughly practical little guides included in "The Home Worker's Series," which will be found of great assistance to those entering upon such work.

Problems of the Future, by Samuel Laing, is now issued in a sixpenny reprint published by Messrs. Watts and Co. The book is already very well known, and we can only advise those who have not read it to make a point of acquiring it and spending a few odd half-hours among the realms of the fascinating mysteries of science. The book has been revised and brought up to date by Joseph McCabe.

Thermometers and Pyrometers.—Messrs. John J. Griffin and Sons have issued a catalogue of their instruments for measuring temperatures from −200° C. to 4000° C., which include almost every variety of mercury thermometer and electrical-resistance pyrometers.

Science Data and Diary is an excellent little pocket-book, issued by Messrs. Philip Harris and Co., of Birmingham, and is replete with useful information on physical and chemical matters, together with a diary, cash account, &c.

We have received from Messrs. Hirschfeld Bros. a set of their *Star Calendar* for 1906, price 1s. net. This consists of 4 cards, suitable for hanging up, on which a rough but clearly marked map of the constellations "as seen in the northern hemisphere in January, February, and March," (or other three months) is given. There is also a calendar for each month, and a list of planets with the constellations in which they are to be found during the month.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Elementary Photo-micrography.

(*Continued from page* 280.)

UNDER any circumstances the lamp or other source of illumination must be provided with some means of adjusting it both vertically and laterally. This is nearly always provided with the oxy-hydrogen jet, and the ordinary microscope lamps are generally supplied with an upright rod upon which they move vertically. The horizontal adjustments are easily obtained by arranging a wooden stand to run lengthwise in the parallel guides of the baseboard, and another stand above this running in parallel guides, whose motion is across and at right angles to the lower stand. The two can be clamped together with a thumb-screw. Such an arrangement could easily be made at home.

It will be found a great convenience if a similar stand be made for the microscope, but the more general method is to arrange a clamp of some sort and shoulders against which the foot may come so that once the microscope has been definitely adjusted in its proper position and the shoulders fitted accordingly it may be an easy matter to replace the microscope at any time and to clamp it securely, with the certainty that it is correctly placed. The Continental stand with its horse-shoe base is so unsteady when in the horizontal position that it absolutely needs some such clamping arrangement, but the English tripod is nearly as steady in this position as when upright, and in the case of one of my own microscopes I have merely to drop the three feet of the stand into three little metal rings screwed on to the baseboard and which were carefully placed correctly once for all.

The loss of light in photo-micrography is so considerable that some means of strengthening the illumination is necessary, and this is done by means of an auxiliary condenser placed between the light and the sub-stage condenser of the microscope. A further necessity for such an auxiliary condenser is due to the importance in photo-micrography of equally illuminating the whole field of view. With ordinary visual microscopic work this is not necessary, and the advanced microscopist rigidly focuses his lamp flame with a view to getting the best image in the particular portion of the field under examination, and cheerfully neglects the comparatively ill-illuminated portions of the field on each side. But this is manifestly not admissible in a photo-micrograph, and any alteration in the focus of the sub-stage condenser to do away with this light streak would not only depreciate the image, but cause a considerable loss of light. So the auxiliary condenser is interposed. There are three ways in which this condenser can be adjusted, and this is a point that is generally insufficiently dealt with in books on the subject of photo-micrography. To begin with, the auxiliary condenser can be adjusted to give parallel light or converged light. Of these, the second is the one usually used, the bull's-eye being so adjusted as to bring the light to a focus 10 inches or so away from the sub-stage condenser, which is then focussed on this point. A little experimenting with the bull's-eye in various positions will be found very instructive and helpful. The plane side of the bull's-eye should be turned towards the light and brought comparatively close to it, as in this position the aberrations of the ordinary uncorrected nearly hemispherical bull's-eye are least in evidence.

(*To be continued.*)

Royal Microscopical Society.

AT a meeting held on October 18 at 20, Hanover Square, Dr. Dukinfield H. Scott, F.R.S., President, in the chair, an old Wilson screw-barrel simple microscope, date about 1750, presented by Major Meade J. C. Dennis, was described by the Secretary, who traced the history of microscopes, focussing by means of a screw cut on the body-tube, from Campani in 1686, Grindl in 1697, Bonnani in 1691, Hartsocker in 1694, to Wilson in 1702, who was followed by Culpepper some time prior to 1738, and Adams in 1746. Mr. E. Moffat exhibited and described a simple portable camera for use with the microscope. It consisted of a vertical telescopic standard drawing out to 28 inches, with a clamp at its lower end to secure it to the edge of the table. At the upper end of the standard was fixed a mahogany board, $\frac{1}{4}$ inch thick × 4 ins. × 5 ins., hinged at the pillar so as to close up, and having a hole in the centre about 3 ins. in diameter. There were two spring clips for securing the dry-plate while making the exposure, and guides for keeping it in position horizontally. The back of the dry-plate was covered by a piece of cardboard painted dead black, the spring clip referred to pressing upon this card. Depending from the board was a tapered bag of black Italian cloth about 17 ins. long with a rubber ring at the lower end to secure the covering to the eye-piece of the microscope. The apparatus can be closed up into a space 5 ins. × 9 ins. × $1\frac{1}{2}$ ins., and will thus go into a large pocket or a knapsack. If made of aluminium the weight should not exceed $1\frac{1}{2}$ lbs. The designer stated that this camera would work well up to 700 diameters, and could be made in brass for 21s., though aluminium would cost more. The Secretary exhibited and described a hand microtome designed and used by Mr. Flatters. It was made of brass and had a tube 3 ins. long and 1 in. inside diameter. The spindle had a screw of 28 threads to the inch, and was actuated at the lower end by three interchangeable notched discs, engaging with a spring stop, the tension of which could be adjusted. Sections could thus be cut varying from $\frac{1}{2000}$ to $\frac{1}{1200}$ inch in thickness for each notch that the disc was turned. The knife-plate was made of hardened brass. The aperture on the upper side was of somewhat smaller diameter than the rest of the tube to prevent the specimen turning. Messrs. R. and J. Beck exhibited the Aske Finlayson "Comparascope" (described in "KNOWLEDGE" for November last, page 281). A paper was read by Prof. Henry G. Hanks, a corresponding Fellow of the Society, entitled "Notes on Aragotite, a Rare Californian Mineral," first described by Mr. F. E. Durand in a paper read before the Californian Academy of Sciences on April 1, 1872. The President called attention to an exhibition of a number of slides from the collection recently presented to the Society by Mr. W. M. Bale, of Melbourne, including some excellently mounted orchid seeds.

Quekett Microscopical Club.

AT the 424th ordinary meeting of the Quekett Microscopical Club, which was held at 20, Hanover Square,

W., on October 20, the President, Dr. E. J. Spitta, F.R.A.S., in the chair, Mr. James Burton read a paper, "On an Easy Method of Staining and Mounting Micro-Algæ and Fungi." The method described may be briefly summarised as follows:—Fix the fungus by one or more drops of 90 per cent. alcohol; follow with 25 per cent. alcohol; wash out with distilled water; add a drop of glycerine stained with Hoffman's blue, and cover. The fungus absorbs the stain from the glycerine, which acts also as a preservative medium.

Mr. F. P. Smith continued his revision of the classification of the spiders of the sub-family Erigoninæ, dealing with those species which he included in the *Walckenaëria* group. A complete bibliography of the group will appear in due course in the Club's journal.

Mr. Smith also described a new British spider from Great Yarmouth, under the name *Anglia hancockii*. It is one of the largest known forms of its sub-family, the Erigoninæ, and appears to be of a very early type.

There was a crowded meeting of members, who listened with regret to the announcement of the death of their veteran Vice-President, Mr. J. G. Waller, who had died on the previous day at the great age of 92. Mr. Waller, who was also well known as an artist and archæologist, joined the Quekett Club in 1868, and had served for a great number of years on the Committee. He was elected President of the Club in 1896 and again in 1897, and served as a Vice-President from 1898 until his death.

Notes and Queries.

Capt. H. D. Foulkes, Fort Purbrook.—Your question raises an interesting and practical point. The resolving power, that is, the ability to separate a maximum number of lines to the inch, is directly dependent upon the numerical aperture of the objective. Therefore a $\frac{1}{6}$ inch of N.A. 1·5 will theoretically have the same powers of resolution as a $\frac{1}{10}$ inch of the same aperture. But to resolve a number of lines and to make them evident to the eye are two different things. The average normal eye is generally stated to be able to distinguish 200 lines to the inch at the normal visual distance of 10 inches. Therefore the image given by either objective must be magnified sufficiently by the eye-piece to make such lines distinguishable by the eye. Now, in theory apochromatic objectives will bear any amount of eye-piecing, but this is not so in practice, even apart from the loss of light, and the higher powers bear high eye-piecing less satisfactorily than the low powers. These limitations are still more evident with achromatic objectives. So that if the maximum resolution be imperatively required a $\frac{1}{6}$ inch of N.A. 1·5 would in practice be less satisfactory than a higher power of the same aperture because of the high eye-piecing required to make the lines visible. But if such maximum resolution be not requisite, in other words if the object does not need such extreme resolution, then there are several advantages attendant upon the use of the lower-powered objective of the same aperture. Firstly, the working distance is greater; secondly, the field of view is larger; thirdly, the loss of light of the two objectives is proportional to the square of the magnification; and fourthly, though the amount of light dependent on the aperture varies as the square of the N.A. (which of course in any pair of objectives increases in a much smaller ratio than the magnification) in the two objectives under discussion the N.A. is identical. Therefore, if the work is of such a nature that moderate magnification only is required the lower-powered objective is preferable. With a pair of still higher powers of equal aperture the lower power would be preferable under almost all circumstances. Let us take for instance a $\frac{1}{12}$ inch achromatic of N.A. 1·25 and a $\frac{1}{14}$ inch of the same aperture, or an apochromatic $\frac{1}{8}$ inch of N.A. 1·4 and a $\frac{1}{12}$ inch of the same aperture. In the first case a quite moderate eye-piece, which the objective can well stand, will show all that a $\frac{1}{12}$ of N.A. 1·25 can resolve and the drawbacks incidental to using a $\frac{1}{14}$ inch of higher magnification, but of the same aperture will bring with them no compensating advantage. With the pair of apochromatics of N.A. 1·4 the $\frac{1}{8}$ inch will require rather higher eye-piecing to make the maximum amount of structure evident, but still it will not be more than an apochromatic can well stand, and so it again is preferable to the $\frac{1}{12}$th.

J. T. Orme, York.—For the chemical tests for mechanical wood pulp and esparto grass (as aids to microscopic examination only) I must refer you to my series of articles in "KNOWLEDGE" on the "Fibrous Constituents of Paper" in the issues of February, March, April, and May of this year, pages 42, 68, 92, and 114. There are no chemical tests in bulk, unless the somewhat untrustworthy use of aniline sulphate as a test for mechanical wood pulp may be looked upon as such. Cross and Bevan's book is the best text-book on papermaking, and deals with such chemical analyses as are practicable for paper. Griffin and Little's book is more a manual of chemistry specially written for papermakers. A very good little book in certain respects is Hertzberg's "Paper Testing," translated by Dr. Norman Evans, and published in 1892 by W. J. Stonhill, at the offices of the *Paper Trade Review*. This is the nearest of the German books to what you require. I am afraid I cannot give you any information on the subject of "smalt," other than you appear to have already, and I am sorry that the many claims upon my time will not permit of my making an analysis for you of the sample you send.

Major E. F. Becher, Cheltenham.—You do not give me the focal length of your bullseye, so it is not quite easy to answer your question definitely. The most obvious suggestion is that the 2-inch objective takes in a larger field than the sub-stage condenser could illuminate, until in altering both condensers you adjusted the latter so that the rays crossed and thus illuminated the whole field. If you were using one of the ordinary Abbe sub-stage condensers and not one of the new macro-illuminators, this is probably the correct explanation. Of course, if your light were correctly focussed upon the object you would get a disc of light smaller than the objective with the 1 inch also, but the spherical aberrations of the bullseye you had interposed between the light and the sub-stage condenser would prevent such accurate focussing, and you would thus get a disc of light large enough to illuminate the whole field taken in by the latter objective. With regard to investigations into the nervous system of insects, a certain amount can be done by careful dissecting, especially in gaining a true impression as to the relations of various parts. This will, of course, need to be done under a dissecting microscope and probably under water, the insect being pinned down to wax run into the bottom of the dissecting dish or to a piece of cork weighted with lead and placed in the dish. I do not think it will be practicable to attempt to stain the nerves and their ganglia *in situ* by any differential stain which will stain the nerves only, whilst the other parts and the chitinous exo-skeleton are left transparent. Your method will therefore be to proceed by means of serial sections, both transverse and longitudinal, and this will need careful preparation of the object beforehand, and a certain amount of experiment before you decide on the best fixing and other reagents and stains. For fairly thick sections the celloidin method will do, and the sections can then be cut with any good microtome. But for really first-rate sections the object must be prepared for infiltration with paraffin (not embedding merely), and be cut on a good rocking microtome such as the well-known instrument made by the Cambridge Scientific Instrument Company. Have you had any experience of infiltration methods? If so, your task will be greatly lightened. You will probably have to stain the sections *upon the slide* by some differential nerve stain. Eau de Javelle would probably be a good method of making the chitin transparent, as it is stated to have no effect upon such delicate structures as nerve endings and to render the chitin permeable to staining fluids, but my experience has been that it requires to be used with great care. The solution should be diluted to 4 or 6 times its volume of water, and the object left in this for 24 hours, or much more, according to size. You might use this reagent before dissecting. If you then wish to go on to make serial sections, I will try to explain how to set about it.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for December.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 7.46 and sets at 3.52; on the 31st he rises at 8.8 and sets at 3.58.

The equation of time is negligible on the 25th.

Winter commences on the 22nd, when the Sun enters the sign of Capricorn at noon. Solar activity is well marked, many spots of late being visible to the naked eye, whilst prominences have been particularly brilliant.

The following table gives the position, angle of the Sun's axis, and the heliographic latitude and longitude of the centre of the Sun's disc:—

Date.	Axis inclined from N. point.	Centre of disc N. or S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Dec. 2 ..	15° 48′ E	0° 33′ N.	310° 44′
,, 12 ..	11° 35′ E	0° 44′ S.	178° 58′
,, 22 ..	6° 58′ E	2° 0′ S.	47° 14′
Jan. 1 ..	2° 8′ E	3° 11′ S.	275° 30′

THE MOON:—

Date.	Phases.	H. M.
Dec. 3 ..	☽ First Quarter	6 38 p.m.
,, 11 ..	○ Full Moon	11 26 p.m.
,, 19 ..	☾ Last Quarter	0 9 p.m.
,, 26 ..	● New Moon	4 4 a.m.
,, 7 ..	Apogee 252,100 miles	10 6 p.m.
,, 23 ..	Perigee 225,800 ,,	10 12 p.m.

OCCULTATIONS:—

Date.	Star's Name.	Mag.	Disappearance.		Reappearance.		Moon's Age.
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N point.	
			p.m.		p.m.		d. h.
Dec. 8	μ Ceti	4·4	5·35	52°	6.43	263°	12 1
,, 9	f Tauri..	4·3	4.49	101°	5.43	220°	13 0
,, 10	γ Tauri..	3·9	4.58	84°	5.56	244°	14 0
,, 10	75 Tauri..	5·3	10.3	60°	11.22	269°	14 5
,, 10	B.A.C. 1391.. ..	4·9	11.37	137°	12.18	197°	14 7
			a.m.		a.m.		
,, 11	Aldebaran ..	1·1	2.52	109°	3.53	238°	14 10

THE PLANETS.—Mercury (Dec. 1, R.A. $17^h\ 58^m$; Dec. S. 25° 26′. Dec. 31, R.A. $17^h\ 4^m$; Dec. S. 20° 23′). Throughout the month the planet is not suitably placed for observation, being in inferior conjunction with the Sun on the 15th.

Venus (Dec. 1, R.A. $15^h\ 14^m$; Dec. S. 16° 48′. Dec. 31, R.A. $17^h\ 53^m$; Dec. S. 23° 23′) is a morning star in Scorpio, rising only a short time before the Sun, hence the planet is not well placed for observation.

Mars (Dec. 1, R.A. $20^h\ 52^m$; Dec. S. 19° 6′. Dec. 31, R.A. $22^h\ 21^m$; Dec. S. 11° 20′) is a feeble object in the evening sky situated in Capricorn and Aquarius, setting about three hours after the Sun.

Jupiter (Dec. 1, R.A. $3^h\ 54^m$; Dec. N. 19° 17′; Dec. 31, R.A. $3^h\ 41^m$; Dec. N. 18° 41′) is a brilliant object in the evening sky and is describing a retrograde path in Taurus. Towards the end of the month the planet will be situated about five degrees directly south of the Pleiades.

The planet is very favourably situated for observation before midnight, and forms with his belt-like markings and bright moons a most interesting object even in very small telescopes.

The equatorial diameter of the planet on the 15th is 48″·5, whilst the polar diameter is 3″·1 smaller. The following table gives the satellite phenomena visible in this country, before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Dec				Dec				Dec			
1	I.	Oc. D.	11 1	10	I.	Oc. D.	7 11	18	I.	Tr. E.	8 22
2	III.	Sh. E.	5 7		I.	Ec. R.	9 47		II.	Sh. E.	8 55
	II.	Oc. D.	6 6	11	I.	Sh. I.	4 52		I.	Sh. E.	9 0
	I.	Tr. I.	8 16		II.	Tr. E.	5 20	19	I.	Ec. R.	6 12
	I.	Sh. I.	8 29		II.	Sh. E.	6 17	24	I.	Oc. D.	10 43
	II.	Ec. R.	9 3		I.	Tr. E.	6 37	25	II.	Tr. I.	7 24
	I.	Tr. E.	10 27		I.	Sh. E.	7 5		I.	Tr. I.	7 56
	I.	Sh. E.	10 42	16	III.	Tr. I.	9 5		I.	Sh. I.	8 42
3	I.	Oc. D.	5 27		II.	Oc. D.	10 34		II.	Sh. I.	8 57
	I.	Ec. R.	7 52		III.	Tr. E.	10 41		II.	Tr. E.	9 58
4	I.	Tr. E.	4 53		III.	Sh. I.	11 16		I.	Tr. E.	10 8
	I.	Sh. E.	5 10		I.	Tr. I.	11 44		I.	Sh. E.	10 55
9	III.	Tr. I.	5 48	17	I.	Oc. D.	8 57		II.	Sh. E.	11 34
	III.	Sh. I.	7 15		I.	Ec. R.	11 43	26	I.	Oc. D.	5 9
	III.	Tr. E.	7 21	18	II.	Tr. I.	5 5		I.	Ec. R.	8 7
	II.	Oc. D.	8 19		I.	Tr. I.	6 10	27	III.	Ec. D.	5 15
	III.	Sh. E.	9 8		II.	Sh. I	6 19		I.	Sh. E.	5 23
	I.	Tr. I.	9 59		I.	Sh. I.	6 47		II.	Ec. R.	6 7
	I.	Sh. I.	10 23		II.	Tr. E.	7 38		III.	Ec. R.	6 57
	II.	Ec. R.	11 39								

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (Dec. 1, R. A. $21^h\ 59^m$; Dec. S. 13° 59′. Dec. 31, R. A. $22^h\ 8^m$; Dec. S. 13° 11′) is due south about sunset and well placed for observation during the early part of the evening; near the middle of the month he sets about 9.20 p.m. The ring, which can be seen in small telescopes with moderate powers, appears well open as we are looking at an angle of 10°, on the northern surface.

Uranus is in conjunction with the Sun on the 26th, and hence is unobservable.

Neptune (Dec. 16, R. A. $6^h\ 41^m$; Dec. N. 22° 9′) rises about 5 p.m. near the middle of the month, and is due south about 1 a.m. The planet is situated in Gemini, some 6° east of the star μ Geminorum, but in small telescopes without setting circles, it is difficult to identify from the numerous small stars in the same field of view, but he can be detected by his motion if observations are made on several successive nights. The planet is in opposition to the Sun on the 31st.

METEORS:—

The principal shower of meteors during the month is the Geminids, Dec. 10 to 12; the radiant is in R. A. VII^h 12^m, Dec. + 33°. The meteors are short and quick, and difficult to record accurately.

Minima of Algol may be observed on the 3rd at 10.49 p.m., the 6th at 7.38 p.m., 26th at 9.21 p.m., and 29th at 6.10 p.m.

TELESCOPIC OBJECTS:—

Double Stars:—1 Pegasi XXI^h 17.5^m, N. 19° 20′, mags. 4·5, 8·6; separation 36″·2.

π Andromedæ 0^h 31.5^m, N. 33°·11′, mags. 4·0, 8·0; separation 36″·3.

α Piscium 1^h 56.9^m, N. 2°·17′, mags. 3·7, 4·7; separation, 3″·6.

ι Trianguli II^h 6.6^m, N. 29°·50′; mags. 5, 6·4; separation, 3″·5.

Clusters:—(♅ VI. 33, 34). The Perseus clusters visible to naked eye and situated about midway between γ Persei and δ Cassiopeiæ. These magnificent clusters are described by Smyth as "affording together one of the most brilliant telescopic objects in the heavens."

(M. 34.) A mass of small stars about the 8th magnitude; not very compact. The cluster is just perceptible to the naked eye about 5° N.W. of Algol.

SUPPLEMENT.

[Although it has not been usual to include fiction within the pages of "KNOWLEDGE," the following discourse, which is but a tale built around a new and possibly important scientific proposition, seems to be one not inappropriate to the contents of a scientific journal.—ED.]

London's Transformation.

A Suggestive Sketch of Days to Come.

(*Continued from page* 286.)

By TEMS DYVIRTA.

[Cornelius Tush was a great American financier, whose modes of business were perhaps not always quite above suspicion. He had hit upon the great idea of diverting the course of the Thames so as to cause the river to flow away to the country, and leave its dry bed in London available for building sites.]

CHAPTER V.

FINESSE.

For some days afterwards Mr. Tush was very busy interviewing many of the leading engineers, contractors, and land agents. To none did he reveal his great idea. He consulted this one about the cost of a big canal, laying down the conditions and circumstances, and leading his adviser to the belief that he was referring to some new Central American waterway. He talked to that one about the price of land in Kent and Surrey, as though about to buy a large estate. With others the expenses of bridges, of dams, of laying roads and other items were discussed. So, bit by bit, he compiled a full and complete estimate of his scheme.

The question was, would it pay? The new river should only occupy approximately the same area as the reclaimed ground, so that as regards the cost of purchasing land, it would only amount to an exchange of country for city property. Then again, much superfluous land would of necessity have to be bought bordering the deviation, but this would in all probability be greatly enhanced in value for building purposes, and might thus pay for the whole. There would then remain the value of, perhaps, 1,000 acres of reclaimed land as an asset; some of this might actually be sold before the water was removed from its surface; the *land* was there right enough. No one could deny that!

Tush decided to play the bear. In compliance with his invitation, numbers of influential men were calling to seek an interview with the great financier. Mr. Singman was one of the first to be ushered into his sanctum. "You require a large building plot centrally situated?" said Cornelius. "Well, I'm not a land agent, but I happen to know of the very article you require, but, can you pay the price?" Singman quoted some figures as to his requirements, and as to the capital he had at disposal to obtain the land. Tush regretted that the plot he knew of would cost considerably more, but then, he urged, it possessed such very suitable characteristics as to make it well worth the extra outlay. It had a large frontage on one of the principal streets of the city, was so situated as to be most easy of access by rail or 'bus, it had a wide pavement in front, and was surrounded by fine buildings. Singman, trying to picture the spot to himself, was somewhat puzzled, and finally broke in by requesting to be informed of the exact locality. "As I have said," retorted Tush, "I am no common land agent; this is an affair of some moment which requires secrecy. I am not at liberty to impart to anyone exactly what property this is, but you can take my word for it, it is all that I describe. It is a great chance for you, and I will give you the opportunity of thinking it over for one day. I will then require a decided answer as to whether you will take it or leave it." Singman thought it over, and, as he had also "kept a bit up his sleeve" by not naming so great a sum as could really be devoted to the object, he eventually decided to scrape together the required amount to purchase the unrivalled site. Very similar dealings were negotiated with other callers, till Tush felt that he had a very respectable sum practically in his hands.

Yet, as he considered carefully over the question, the vastness of the project and the many difficult problems involved filled his mind with doubts as to the feasibility of the scheme. The few sales of land which he had so far actually contracted for would, after all, bring in but a small fraction of the enormous capital necessary to complete the work. If but one of the land owners on the site of the deviation refused to sell, the whole plan might need alteration. The Bill which it would be necessary to bring before Parliament would certainly receive much opposition. The railway companies might object, as might the steamboat owners, and too large a compensation claimed.

On the other hand the whole matter had been very carefully gone into and it *ought* to pay handsomely. It was not likely to fail like the Panama Canal Company had done after spending sixty million pounds.

Could the Government do anything? Tush decided to lay the project before them; leave them to disentangle the multitudinous obstacle while he could make such stipulations as to guarantee for himself a goodly perquisite.

A few days later Tush was closeted with one of the principal heads of the department concerned. Arguments were adduced, such as a possible substantial addition to the revenue, an investment as good as the purchase of the Suez Canal shares, which increased six times their value in twenty years, and many other nice plums, calculated to attract a tottering ministry; but the Right Honourable Gentleman addressed could only

XUM

reply that the matter was hardly one which the Government could undertake, and that the public body most concerned, and, therefore, the proper quarter to appeal to, was the London County Council.

Interviewing the officials of the latter, and impressing upon them the great benefits to be derived from the scheme, the lowering of rates by the huge income from rents, and the great improvements to be introduced to the city, Tush was again doomed to disappointment by being informed that, on the whole, the scheme was considered to be of too speculative a nature for this body to undertake.

Nothing remained, therefore, except to endeavour to further the original idea of the formation of a huge company. An attractive prospectus would have to be concocted and issued broadcast, then, if the capital was forthcoming it would be necessary to get a Bill passed through Parliament to obtain rights for the compulsory sale of land to the company and the abolition of various vested rights.

A day or two afterwards Mr. Singman was again at the office craving an interview with the universal provider of moneys and lands. "I am getting a little uneasy," he confessed, "about our arrangements. You have pictured to me an ideal site for my establishment, yet though I have hunted London high and low I can find no such perfect place. Where does it exist? You might, at all events, name the district, if not the street, in which it is." The wily Tush was a little puzzled as to how to appease the curiosity of his client, not wishing to have to allow that the transaction was certainly problematical and uncertain, and not likely in any circumstances to be completed for some years to come. However, by stating that it was not far from the Houses of Parliament, that it was not south of the Thames, and that it faced one of the main thoroughfares, he succeeded in satisfying his over-inquisitive friend for a bit. Just as Singman was leaving the room, however, a thought struck him. "I thought you said it was in the *city?*" he suddenly interrogated. "No," replied Tush with the greatest calmness, "Westminster."

The next caller was FitzEdmund. "With respect to this plot of land, Mr. Tush, about which we have been negotiating, I happened to meet a day or two ago a gentleman who was dining with you that day, if you remember. Well, he mentioned that you were arranging to sell him a great plot of land, too. It isn't the *same* by any chance, is it?"

"Oh dear no; your theatre is to be in the vicinity of the Strand."

Having thus disposed of another awkward customer, Tush was feeling a little more relieved, when Lord Whittingbourne was announced. "My dear Mr. Tush, I don't at all understand what is going on. While sitting in your waiting-room just now, a gentleman came in, having just left you, and staring at me said, 'Oh, so I s'pose he's going to sell *you* a bit of City property, *too*, eh?' 'That is so, sir,' I replied, 'but I do not understand it all.'"

"Oh, there's nothing in that," said Tush, "that man couldn't scrape out the dollars to outbid you."

Then rumours spread around and were whispered here and there in the highways and by-ways. The great American financier had gone off his head! He had been selling plots of building land in the City freely to all who applied to him, and had already negotiated for the sale of such an amount as could not possibly be disposable in all the City of London!

Tush at last got to hear of these rumours. It would be absolutely necessary to make some explanation to appease the anxiety of those concerned, but how could it be done?

After long and careful consideration Tush came to the conclusion that there was but one solution to the difficulty. "Trust to truth." Accordingly each of the would-be purchasers had to be sent for over again, and each had to be carefully mollified and soothed, and to be persuaded that immediate possession was of no importance; and then the great scheme was gradually laid before them, and the certainty of its success impressed upon these "co-originators of the scheme, whose names would be indelibly connected with this grand and beneficial concern."

And soon the world at large were also taken into confidence. The glowing and persuasive prospectus convinced all men of the soundness and feasibility of the scheme, so that before many weeks had passed, a new and colossal company had sprung into existence, backed by the wealth of the nation.

CHAPTER VI.

PROGRESS.

Three solid years had slipped by since the banquet at the Savile; and what a change was manifest!

Cornelius Tush who, one way and another had by now recouped most of his lost fortune, stood once again on Westminster Bridge surveying the river and its surroundings. How different now the aspect to that which had met his eye three years before! That vast expanse of water had now dwindled considerably. Great wooden structures rose from the water. Caissons and hoardings hemmed in the river and limited its flow. Beyond, extensive banks of brown earth supported temporary lines of railway, along which crawled long trains full of earth dug from Surrey fields to fill in the bed of the river. A narrow strip of water was left along the southern bank forming a canal, crowded with barges.

Moving down from off the bridge, Cornelius approached a wooden shed among the lines bearing the sign "Temporary Offices," and soon after emerged with engineers, and foremen, and others, and was ensconced in an inspection car to go a trip round the works. The engine whistled and the little train rattled off along the shaky, roughly-laid line, passed St. Thomas' Hospital and the great Houses of Parliament opposite, and on it jogged towards Wandsworth. Vast were the works in progress. On all sides gangs of men at work digging, picking, shovelling, laying new lines, tearing up old ones, fixing up great cranes, making bridges and dams, demolishing old houses, erecting new sheds.

At Wandsworth was the junction where the deviation began. And here were in course of erection some large under-water turbines, which, by the flow of the river, were to convert its latent power into electrical energy, and to supply London with that most valuable commodity. Up the bed of the Wandle, that little stream which but a few years before had run so placidly and unostentatiously among the green meadows and pollard willows, was now a vast valley of excavations. Numerous steam diggers were puffing away at their gigantic tasks. Temporary bridges were being constructed for the railway lines and various roads passing over it. On went the inspection train towards Croydon. Here the work was stupendous. An enormous cutting, over 100 feet deep and of great width, was being excavated. Hundreds of acres of suburban land

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were covered with this turmoil. Houses of all sorts, from the humblest cottages to the most magnificent villas, had fallen a prey to the Act of Parliament sanctioning the great work. Even whole villages had been swept away by the remorseless hand of the now celebrated Tush.

At various points the train stopped, while Tush got out to interview the officials or inspect some new piece of work, and then on he would go again. Now the distant form of the Crystal Palace, with its two towers so familiar to suburban *habitués*, came in view as the little train rattled along near the south end of its grounds. Even further was the great ditch continued through Beckenham and right on towards Greenwich, where new docks were to be constructed, with great locks to cut off the tide.

In some places, where land was not so precious, the spare earth was piled up into small mountains, instead of being carried all the way round to the City, and these would, in the future, form picturesque little hills overlooking the river.

One of the greatest difficulties proved to be the many railroads connecting the Metropolis with the south. Either there would be required a large number of long bridges, or they would need to be so altered and arranged that a number of them could utilise the same bridge, which was more economical in many ways. Some, on a low level, could tunnel beneath the New River.

Tush, satisfied with his tour of inspection, now took the ordinary train to convey him to the City, where he was to attend a meeting of the company, and troublous times were beginning to overshadow its peace and prosperity.

The "Thames Deviation Construction Company," with its capital of £50,000,000, was one of the biggest commercial concerns ever undertaken, and was not the chairman also one of the biggest financiers the world had seen? Yet discontent was rife among the shareholders. They wanted to know more. They asked this and they asked that, but they were always put off with vague replies. "Mr. Tush has arranged that," was considered a sufficient answer to allay all despondency and doubt as to certain possible difficulties. Then more sinister rumours began to get about; one of them, for instance, was to this effect:—

A certain gentleman in business in the City owned a small villa and a few acres of land near Carshalton. About three years ago a stranger, giving the name of Jones, called to see him and asked whether he was willing to sell the freehold of his little property. In due course the transaction was completed, and Mr. Jones became owner of the land on very favourable terms. Since then the land had been purchased by the Deviation Company for a very handsome sum; those knowing its true value being much surprised at the magnanimity of the great company. Well, all this might not have seemed a matter of any importance had not the worthy City merchant one day chanced to have pointed out to him the great Tush. "That Tush!" he said, "why I could swear that that is the man Jones, who bought my house at Carshalton." And then other stories of a very similar nature got about.

It transpired that about the time the company was first formed, Tush had become a very large shareholder in the "Conrad R. Pickie Steam Digger and Excavator Company," of Pittsburg, U.S.A., and that this firm, though not the lowest contractors, had supplied nearly all the machines used by the company for excavating. So, too, a certain architect, to whom much work had been entrusted, was found to be "subsidised" by Tush. Either under his own name, or that of his agent Bateson, he seemed to be interested in many different concerns connected with the great undertaking.

Thus it gradually began to leak out that the great capitalist was making money "hand over fist" in a number of different lines, quite apart from the main company. Indeed, it was suggested by some of the more pessimistic that he had already got rid of the greater part of his "Deviation" shares during the great boom of a year ago, and that he was now running the thing so as to suit his own interests rather than those of the shareholders.

Still all these awkward rumours were explained away by the co-directors and officials of the company, and things went on smoothly enough for some years. As the completion of the works began to become manifest, hopes rose in people's minds, and the shareholders cared not what Tush did, only so long as the great work should be satisfactorily completed.

CHAPTER VII.

THE OPENING.

At last all was ready. The huge cutting of the "New Thames" was complete; all except the dam which still held the waters, and bade them flow on in the path they had pursued for centuries. Once the dam was cut all would be changed, and the waters, rushing wildly over fields and pastures new, would dash onward to find their new course to the sea.

This, then, should be a most eventful occasion, and a fitting ceremony was arranged to take place. Large wooden stands were erected for the accommodation of the thousands of spectators. Royalty itself was to honour the proceedings with its august presence and support. All the big wigs in England had expressed their intention of attending. Cornelius had decided, in his usual personally ambitious manner, that this great occasion was not only to be the opening up of the new river, but that it would incidentally form the ceremony of exonerating him personally from all the wicked slanders that had been circulating more and more freely. He had made numerous plausible stories which *ought*, he thought, to explain away any harmful intentions on his part. But, unfortunately, as soon as one was disposed of, dark tales sprung into life about some other enormity that he was supposed to have committed. Now at last he hoped they were all satisfactorily explained, and that his pure and straightforward patriotism would be proclaimed to the whole world.

Then the day arrived! Wandsworth, the town which was now to be cut clean in two by a vast abyss, while a large portion of it had disappeared into that abyss, was *en fête*. The river beyond swarmed with boats of all kinds (for the rush of water was not to be so sudden as to cause any serious difference to the river that day). Flags flew from every suitable point. Strains of music and joyous voices rose from all around. The only sombre-looking spot was the vast brown excavation extending southward as far as the eye could see, on which all the interest hinged.

As the church bells slowly boomed forth the midday hour, bands struck up the National Anthem, and the roaring of thousands of throats rose in their loyal greetings to the occupants of a Royal carriage as it raced into the great enclosure surrounding the spot where the puny work was about to take place which

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would represent the first cutting away of the enormous dam.

And there were two other figures which attracted the attention of the thousands of onlookers. One was the man to whose master-mind this huge undertaking was due. Petty squabbles could, on an occasion like this, be forgotten or set aside, and the general public only recognised in that figure the founder of another prop, another addition to our Empire, of more importance perhaps than the settling of an extensive new Colony or the discovery of unknown territories, since the population of the reclaimed area was sure to become very shortly equal to that of a large Colony.

But what was the other figure? Equally fascinating to the public eye, and yet for a very different reason. The one with the sagacious, clear mind, sharp even to cunning, large minded even to unscrupulousness; the other innocence personified—a simple but extremely pretty little girl, Miss Libertia Tush. All eyes were drawn to gaze upon the charming childish figure, clad in white, with the huge bouquet, which she so gracefully deposited in Royal hands.

The sun broke forth in all his splendour, and cheers rent the air as the first trickle of water passed from the Thames into the new cutting. Everyone was enthusiastic and highly pleased. All except one, and that was the very person who should have been elated above all others at seeing the work of his brain brought into activity, and to realise that his ambitious dreams were actually accomplished! But his expectations in other lines had not been realised.

The highest in the land have to be guided by the feelings of the majority of their subjects. This great ceremony had very nearly to take place without that royal presence, the request for which had only been granted after special pleadings. The founder and chairman had expected honourable recognition of his great work before this; but nothing of the sort, no kind of encouragement had been held out to him, and he had only hoped that the announcement of his reward had been deferred to the final moment of the opening, then did he expect to be the recipient of such honour as would have for long thrown off the scurrilous and menacing attacks that had been made by envious persons as to his private financial transactions. But nothing had come of it! He had been received by Royalty with marked coldness, even though the eyes of the whole Court were attracted to Libertia, and had it not been for the ardent admiration shown for his little daughter, an awkward scene might have ensued. With the audacity acquired by one supreme in his own line, and with the anger of being foiled in his ambitions, he had actually enquired point blank whether he would be likely to receive such recognition from the hands of his august visitors as might be commensurate with the work which he had now brought so near completion. What was intimated in reply was nothing more nor less than a snub. He, Cornelius J. Tush, snubbed! It was more than he could stand. "Your bloated aristocrats could go to—where they like. What cared he for the beastly rags fluttering overhead? They could have the Royal ensign flying there, but the Stars and Stripes must come down. *He* wasn't one of that fat, phlegmatic, apoplectic John Bulls. No, thank goodness!" And so Tush turned on his heel, determined once and for ever to sever his whole connection with these schemes for the improvement of a "foreign town."

And so he did. His whole financial interest in the affair became transferred to other hands, and though his name, for various reasons, was still retained on the company's books, he, with his wife and child, returned to re-found their home in the States.

(To be continued.)

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